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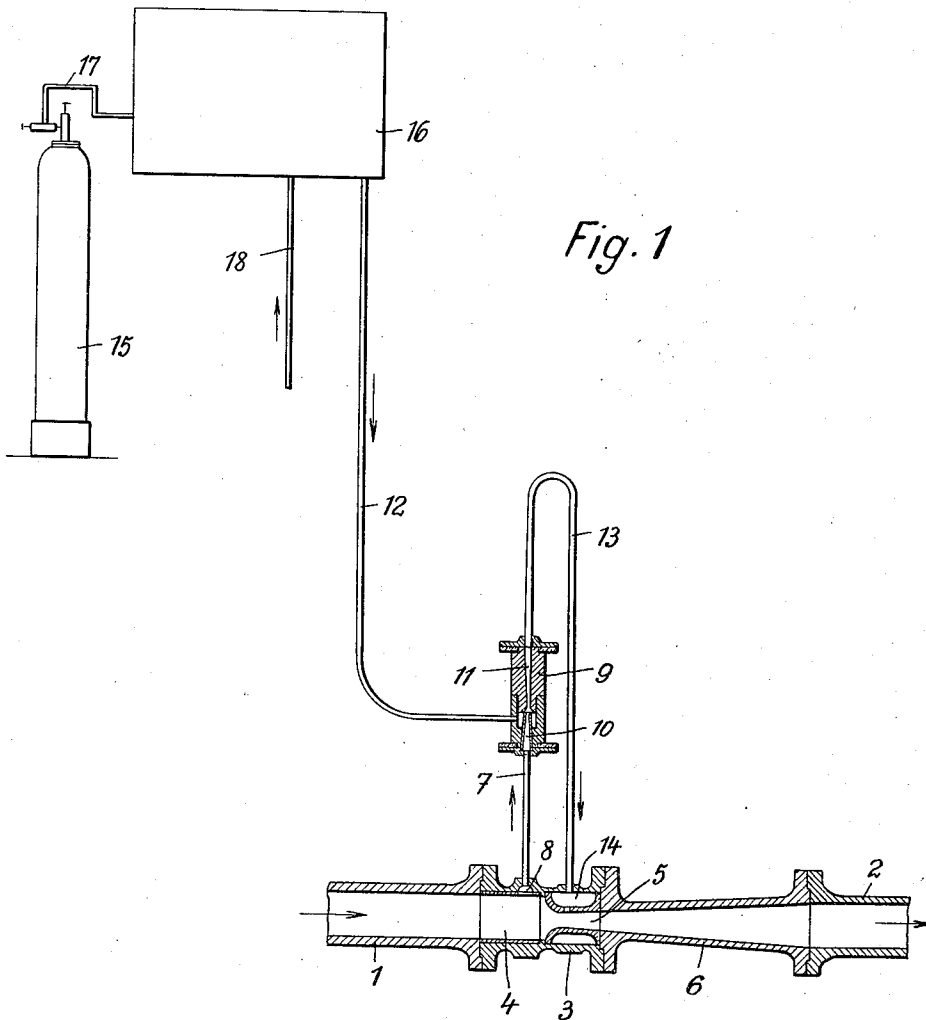
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2,062,231

TREATING WATER

Filed Oct. 14, 1933

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 2

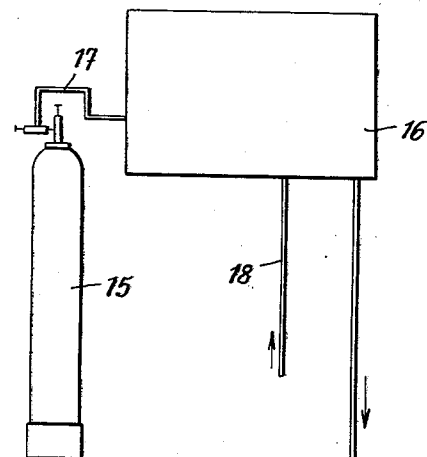
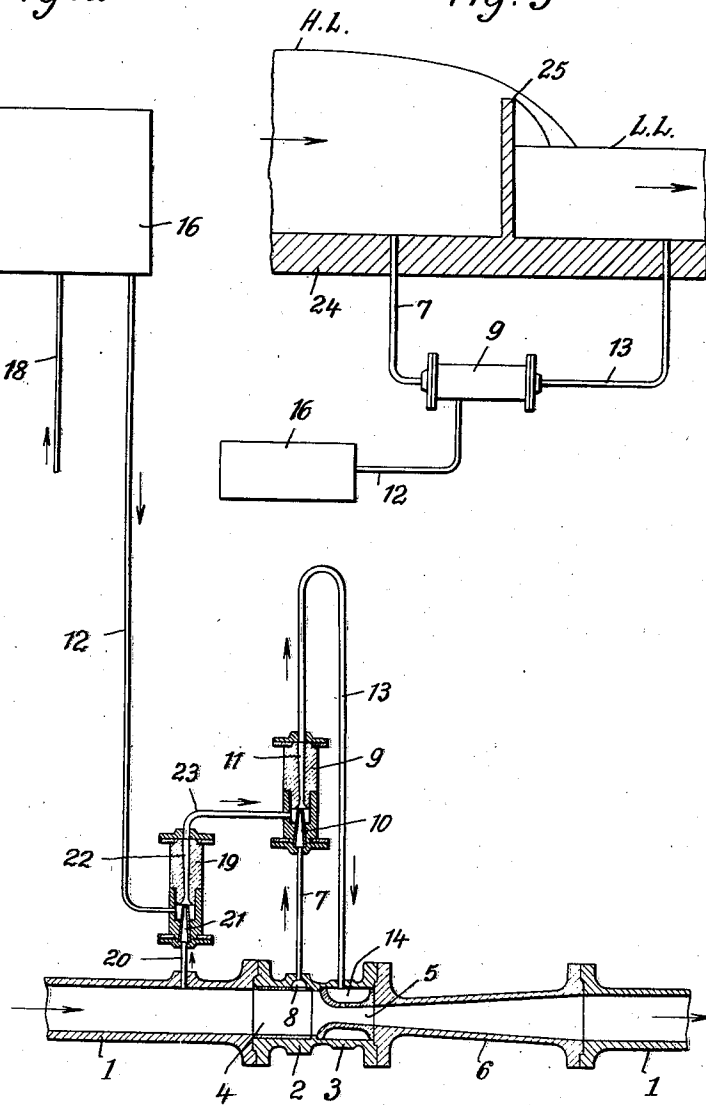


Fig. 3



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TREATING WATER

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5 Claims. (Cl. 210—28)

My invention relates to apparatus for introducing a gaseous or liquid additional medium of lower pressure into a gaseous or liquid principal medium of higher pressure.

As a rule, the introduction of an additional medium into a principal medium can be effected without any considerable difficulties if the principal medium is not under pressure. However, if the principal medium is under pressure, the additional medium must be introduced against this pressure by compressing or conveying apparatus. Such apparatus may be pumps, steam injectors, water-jet elevators in which means are required for producing a flow of water of higher pressure, or any other suitable apparatus.

It is an object of my invention to provide an apparatus of the kind described in which compressing or conveying apparatus, and the complication and power consumption they involve, are dispensed with by utilizing the kinetic energy of a flowing principal medium for introducing the additional medium.

To this end, in an apparatus embodying my invention I may provide a main conduit for the flow of the principal medium which is under higher pressure, a shunt conduit which connects a point of the main conduit where the pressure of the flowing principal medium is higher, to a point of the main conduit where it is lower, and a pressure-reducing device in the shunt conduit. The additional medium is conducted to the pressure-reducing device and delivered to the shunt conduit which in turn delivers it to the main conduit.

I may provide a pressure-reducing device, for instance, a Venturi tube, for producing the required pressure gradient between the points where the shunt conduit is connected to the main conduit, but I may also dispense with such a device altogether, and utilize the gradual reduction of pressure which friction causes in the main conduit, by connecting the ends of the shunt conduit to two points of the main conduit which are sufficiently spaced from each other.

The pressure-reducing device in the shunt conduit may also be a Venturi tube, or it may be of any other suitable type, and, by way of example, an ejector will be shown and described as the pressure-reducing device in the shunt circuit, where it is operated by the shunted principal medium.

In the accompanying drawings, three types of apparatus embodying my invention are illustrated more or less diagrammatically by way of example.

In the drawings

Fig. 1 is a partly sectional elevation of an ap-

paratus in which the principal medium flows in a pipe, and a single shunt conduit with a single pressure-reducing device therein is provided.

Fig. 2 is a partly sectional elevation of an apparatus which is similar to the one illustrated in Fig. 1 but has two shunt conduits, each with a pressure-reducing device, and

Fig. 3 is a partly sectional elevation of an apparatus in which the principal medium flows in an open channel.

Referring now to the drawings, and first to Fig. 1, the pressure-reducing device for the main conduit is inserted between two pipes 1 and 2 of the main conduit. The medium flows from 1 to 2, as indicated by the arrows. The pressure-reducing device is partly housed in a sleeve 3. A perforated liner 4 is inserted at that end of the sleeve 3 which is connected to the pipe 1, and a perforated Venturi tube 5 is placed at the rear of the liner 4 in the sleeve 3. The inlet of the Venturi tube faces the rear end of the liner, and its outlet is connected to a tapered pipe 6 whose rear end is connected to the pipe 2.

The shunt conduit is a U-shaped pipe line. Its upflow pipe 7 extends upwardly from a chamber 8 in the sleeve 3 and opens into the casing 9 of an ejector or water-jet elevator, a cone 10 being arranged in line with the upflow pipe 7, and a cone 11 being formed in the casing 9 in line with the cone 10, as is known in devices of this type, for instance, steam injectors. The additional medium is admitted to the space between the two cones through a pipe 12, and the mixture of shunted principal medium and additional medium is discharged into the downflow pipe 13 whose lower end opens into a chamber 14 surrounding the Venturi tube 5 in the sleeve 3.

The apparatus illustrated in Fig. 1 may be used for introducing an aqueous solution of chlorine into water which flows in the main conduit 1, 2. A supply of chlorine is stored under pressure in a cylinder 15 and conducted to a mixing tank 16 through a pipe 17. Water is supplied to the tank through a pipe 18. The mixing means in the tank 16 have not been illustrated as they are old in the art.

The aqueous solution of chlorine which has been prepared in the tank 16, is conducted to the casing 9 through the pipe 12. As the pressure in the chamber 8 to which the upflow pipe 7 is connected, is higher than that in the chamber 14 which surrounds the Venturi tube 5, and into which the descending pipe 13 opens, a portion of the water flowing in the main conduit 1, 2 is tapped to the shunt conduit 7, 13 in which it

risers and descends as indicated by the arrows, operates the ejector or water-jet elevator in the casing 9, mixes with the solution from pipe 12, and finally returns to the main conduit 1, 2 through the chamber 14 and the perforated Venturi tube 5. Extra power and extra apparatus for introducing the additional medium are obviously not required, as the kinetic energy of the water flowing in the main conduit 1, 2 is utilized for operating the pressure-reducing device in the casing 9.

Chlorine in aqueous solution or in gaseous form is introduced for the purpose of de-germination, extermination of algae, etc. For many other purposes it is necessary to introduce gases or liquids as additional media into other gases or liquids which are flowing. Such purposes may be effecting chemical reactions, a change of temperature in the principal medium, purification, de-germination, and many others, and my apparatus may be used for all of them.

The additional medium, or media, may be under no pressure, or under low pressure. By the pressure-reducing device in the main conduit 1, 2 the flowing principal medium is subjected to a temporary reduction of pressure by which the flow in the shunt conduit 7, 13 is established. A reduction of the pressure in the shunt conduit is effected by the pressure-reducing device in the casing 9, for drawing into the shunt conduit the solution from the mixing tank 16. By suitably designing the apparatus, the pressure in the casing 9 may be reduced to atmospheric or even lower pressure, and the additional medium or media, gases or liquids, may be introduced into the casing 9 through pipe 12 by gravity, as shown in Fig. 1, or they may be sucked in by the ejector or elevator action of the device.

The Venturi tube is a particularly suitable device for reducing the pressure because in a Venturi tube the relation between temporary and permanent loss of pressure in the medium flowing through the tube, is most favorable. The Venturi tube is therefore preferred as the pressure-reducing device for the main conduit, although other devices, for example stowing flanges, stowing disks, perforated plates and the like, may be provided, or such devices may be dispensed with altogether and the frictional resistance in the main conduit may be employed, as explained above.

A Venturi tube, as is known in the art, is a part of a pipe line and has a conical or parabolic longitudinal section. At the inlet of the Venturi tube, its inside diameter is equal to the inside diameter of the pipe line, at the so-called nozzle, the tube is restricted to a certain smaller diameter and thereafter widens again to the full inside diameter of the pipe line. When gaseous or liquid media flow through the pipe line (the main conduit 1, 2), the flow velocity increases toward the nozzle of the Venturi tube and the pressure decreases correspondingly, whereas when the medium flows on through the following gradual enlargement from the nozzle to the full inside diameter of the pipe line, the velocity decreases and the pressure increases. In a suitably designed Venturi tube, the permanent loss of pressure is no greater and frequently less than 15% of the temporary loss of pressure prevailing at the narrowest section, the nozzle. If, for example, the temporary loss of pressure between the full diameter at the inlet of the Venturi tube and the smallest diameter at the nozzle amounts to a water column or head of 10 meters, the

permanent loss of pressure in the pipe line beyond the outlet of the Venturi tube only amounts to a head of 1.5 meters. If therefore the head at the inlet of the Venturi tube is 30 meters, the pressure at the nozzle amounts to 20 meters and in the pipe line beyond the Venturi tube it amounts to 28.5 meters.

The ejector or water-jet elevator in the casing 9 is preferably so designed that it will exert suction at the end of pipe 12 if the pressure of the medium supplied through pipe 7 is 1.7 to 2 times as high as the pressure at the outlet of the ejector or elevator against which it delivers.

Instead of an ejector or elevator, other pressure-reducing devices, such as Venturi tubes, stowing flanges, stowing disks, perforated plates, etc., may be provided in the shunt conduit 7, 13.

Table I shows some results of the operation with an apparatus such as shown in Fig. 1, the first column indicating the pressures in the main conduit 1, 2 at the inlet of the Venturi tube 5, the second column indicating the corresponding pressures at its nozzle, the third column indicating the ratio of the pressures from the first and second columns, and the fourth column indicating the quantities of chlorine solution per unit of time which the ejector or elevator in the casing 9 delivers. The pressures are kilogrammes per sq. centimeter, and the quantities are liters per hour.

It will appear from the table that quantities of additional medium (chlorine solution) were introduced at the rate of 72 to 800 liters per hour and against pressures of .5 to 1.4 kilogrammes per sq. centimeter, without expenditure of foreign power.

Table I

Pressures, kilogrammes per square centimeter, at—		Ratio of pressures in columns (1) and (2)	Delivery of ejector in casing 9, liters per hour
(1) Inlet of Venturi tube	(2) Nozzle of Venturi tube		
(1)	(2)	(3)	(4)
2.4	1.2	2:1	248
2.4	1.3	1.85:1	218
2.4	1.4	1.7:1	72
2.2	1	2.2:1	514
1.9	.5	3.8:1	800

If, owing to the particular conditions in a given apparatus, the pressure of the additional medium at the inlet of the ejector or elevator in the shunt conduit 7, 13 is still too high, a second shunt conduit may be connected to the pressure-reducing device in the first shunt conduit, and, if, necessary, a third, fourth, etc. shunt conduit may be arranged in a similar manner. Every shunt conduit has a pressure-reducing device and the additional medium is conducted to the pressure-reducing device in the last shunt conduit which delivers it to the pressure-reducing device in the next conduit etc., until finally it is discharged into the chamber 14 of the main conduit 1, 2.

Fig. 2 illustrates an apparatus which is similar to the one illustrated in Fig. 1 but has two shunt conduits, each with a pressure-reducing device. The primary shunt conduit 7, 13 is arranged as described with reference to Fig. 1, but the pipe 12 is connected to the casing 19 of an ejector or elevator in a subsidiary shunt conduit, with an upflow pipe 20 connected to the pipe 1 of the main conduit, cones 21 and 22 in the casing 19, and a delivery pipe 23 which is connected to the

casing 9 in the primary shunt circuit 7, 13 instead of the pipe 12, Fig. 1.

Instead of a chlorine solution, a soda solution may be prepared in the tank 16 by suitable dosing means whose valves and regulating members have been omitted. The liquid flowing in the main conduit effects a temporary loss of pressure in the Venturi tube 5 and a reduction of pressure in the casing of the ejector or elevator in the primary shunt conduit 7, 13 which reduction is in excess of the temporary loss of pressure in the main conduit. If, notwithstanding the reduction, the pressure at the inlet of the primary pressure-reducing device in the casing 9 is still higher than atmospheric pressure, the subsidiary conduit 20, 23 is provided. The ejector or elevator in this conduit is supplied with liquid under pressure from the pipe 1 of the main conduit through up-flow pipe 20 (or with liquid under pressure from some other source. The reduction of pressure in the ejector or elevator of the primary shunt conduit 7, 13 is transmitted to the ejector or elevator in the subsidiary shunt conduit 20, 23 through the delivery pipe 23 and this results in a further reduction of pressure at the subsidiary ejector in the casing 19, and the pressure at the end of pipe 12 may fall to atmospheric pressure or to a partial vacuum. The solution or other additional medium can now be delivered to the subsidiary ejector by gravity, or sucked into the subsidiary ejector.

Table II shows some results obtained with an apparatus such as illustrated in Fig. 2, and it will appear that with a temporary loss of pressure of only .2 to .25 kilogrammes per sq. centimeter (column 3) in the main conduit 1, 2, the pressure at the subsidiary ejector in the casing 19 may be reduced to atmospheric pressure (0.0 in column 5) or to a partial vacuum, when the pressure at the primary ejector in the casing 9 is still .51 to .82 kilogrammes per sq. centimeter.

Table II

Pressure, kilogrammes per square centimeter, at—		Temporary loss of pressure, kilogrammes per square centimeter	Pressures, kilogrammes per square centimeter, at nozzle of—	
(1) Inlet of Venturi tube	(2) Nozzle of Venturi tube		Primary ejector	Subsidiary ejector
(1)	(2)	(3)	(4)	(5)
1.3	1.1	.2	.82	0.0
1.1	.9	.2	.62	(x)
1.05	.8	.25	.51	(xx)

(x) partial vacuum, 77 liters per hour sucked in.
(xx) partial vacuum, 133 liters per hour sucked in.

Thus, with two pressure-reducing devices connected in series in which temporary loss or reduction of pressure is effected by flowing gases or liquids, suction is obtained with comparatively slight temporary loss or reduction of pressure in the main conduit 1, 2, (only .2 to .25 kilogrammes per sq. centimeter in the example according to Table II) while with only one ejector or elevator in the shunt conduit, as in Fig. 1, a temporary pressure reduction of 1 kilogramme per sq. centimeter, or more, is required in the main conduit. In other words: By providing two or more pressure-reducing devices the permanent loss of pressure in the main conduit 1, 2 which, as stated above, is about 15% of the temporary loss, is reduced to a minimum and a corresponding saving of power is achieved.

In the case of liquids flowing in open conduits or channels, other liquids which are at a lower level, may be introduced in a similar manner by sucking them up by apparatus of the kind described. For instance, a so-called open Venturi tube, i. e., a channel having a restriction like that of a "closed" Venturi tube, may be employed for such purposes.

Various other means may also be employed and Fig. 3 shows diagrammatically an arrangement in which the different water levels before and behind an overfall weir are employed for introducing an additional medium into the principal medium flowing in a channel. The liquid into which the additional medium is to be introduced, flows in an open channel 24 in the direction of the arrows and over a weir 25, flowing in at the higher level H. L. and flowing out at the lower level L. L. The shunt conduit 7, 13 is connected to the channel 24 at a point before, and at a point behind the weir 25. The casing 9 of the pressure-reducing device is connected to a container 16 for the additional liquid by the pipe 12, as described with reference to Fig. 1. The liquid from container 16 is sucked in by the reduction of pressure in the casing 9 and introduced through pipe 13. Two or more pressure-reducing devices may be connected in series in this case also, as described with reference to Fig. 2.

I claim:

1. In an apparatus for continuously feeding a fluid medium at a lower pressure into a flowing principal medium at a higher pressure, comprising a main conduit in which the higher pressure medium flows, means in said main conduit to reduce the pressure therein and thereby to cause variations in pressure therein at different points in the conduit as the result of the flow of fluid therethrough and thus to produce points of higher and lower pressure, a shunt conduit connected to said main conduit at a point of higher pressure and at a point of lower pressure adjacent said pressure reducing means, a separate container for a fluid medium at a lower pressure than the pressure in said shunt conduit, a third conduit connecting said container to said shunt conduit, and means in said shunt conduit at the point of connection of said third conduit to reduce further, by the kinetic energy of the higher pressure medium flowing therethrough, the pressure in the shunt conduit to induce the flow of lower pressure medium into the shunt conduit, thereby to introduce the lower pressure medium into the higher pressure medium.

2. In an apparatus for continuously feeding a fluid medium at a lower pressure into a flowing principal medium at a higher pressure, comprising a main conduit in which the higher pressure medium flows, means in said main conduit to reduce the pressure therein and thereby to cause variations in pressure therein at different points in the conduit as the result of the flow of fluid therethrough and thus to produce points of higher and lower pressure, a shunt conduit connected to said main conduit at a point of higher pressure and at a point of lower pressure adjacent said pressure reducing means, a separate container for a fluid medium at a lower pressure than the pressure in said shunt conduit, a third conduit connecting said container to said shunt conduit, and means at the point of connection of said third conduit to reduce further the pressure in the shunt conduit to induce the flow of lower pressure medium into the shunt

conduit, thereby to introduce the lower pressure medium into the higher pressure medium.

3. In an apparatus for continuously feeding a fluid medium at a lower pressure into a flowing principal medium at a higher pressure, comprising a main conduit in which the higher pressure medium flows, means in said main conduit to reduce the pressure therein and thereby to cause variations in pressure therein at different points in the conduit as the result of the flow of fluid therethrough and thus to produce points of higher and lower pressure, a shunt conduit connected to said main conduit at a point of higher pressure and at a point of lower pressure adjacent said pressure reducing means, a separate container for a fluid medium at a lower pressure than the pressure in said shunt conduit, a pressure reducing device in said shunt conduit, to reduce further, by the kinetic energy of the higher pressure medium flowing therethrough, the pressure in the shunt conduit, a second shunt conduit connected to said main conduit at a point of higher pressure and to said first shunt conduit at a point where the pressure therein is reduced by said device, a second device in said second shunt conduit to reduce still further, by the kinetic energy of the higher pressure medium flowing therethrough, the pressure in the second shunt conduit to induce the flow of lower pressure medium into the second shunt conduit, and a conduit connecting said container to said second shunt conduit at a point where the pressure therein is reduced by said second device, thereby to introduce the lower pressure medium into the higher pressure medium.

4. In an apparatus for continuously feeding a fluid medium at a lower pressure into a flowing

principal medium at a higher pressure, comprising a main conduit in which the higher pressure medium flows, a Venturi tube in said main conduit, a shunt conduit connected to points of said main conduit above and within said Venturi tube, a separate container for a fluid medium at a lower pressure than the pressure in said shunt conduit, a third conduit connecting said container to said shunt conduit, injector means in said shunt conduit at the point of connection of said third conduit, to reduce further, by the kinetic energy of the higher pressure medium flowing therethrough, the pressure in the shunt conduit to induce the flow of lower pressure medium into the shunt conduit, thereby to introduce the lower pressure medium into the higher pressure medium.

5. In an apparatus for continuously feeding a fluid medium at a lower pressure into a flowing principal medium at a higher pressure, comprising a channel for the higher pressure medium, a weir in said channel, a shunt conduit connected to said channel above and below said weir, a separate container for a fluid medium at a lower pressure than the pressure in said shunt conduit, a third conduit connecting said container to said shunt conduit and means in said shunt conduit at the point of connection of said third conduit to reduce further, by the kinetic energy of the higher pressure medium flowing therethrough, the pressure in the shunt conduit to induce the flow of lower pressure medium into the shunt conduit, thereby to introduce the lower pressure medium into the higher pressure medium.

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