Sept. 14, 1965 W. E. CLACK 3,205,830

PROPORTIONING FLUID PUMP

Filed Feb. 12, 1964 2 Sheets-Sheet 1

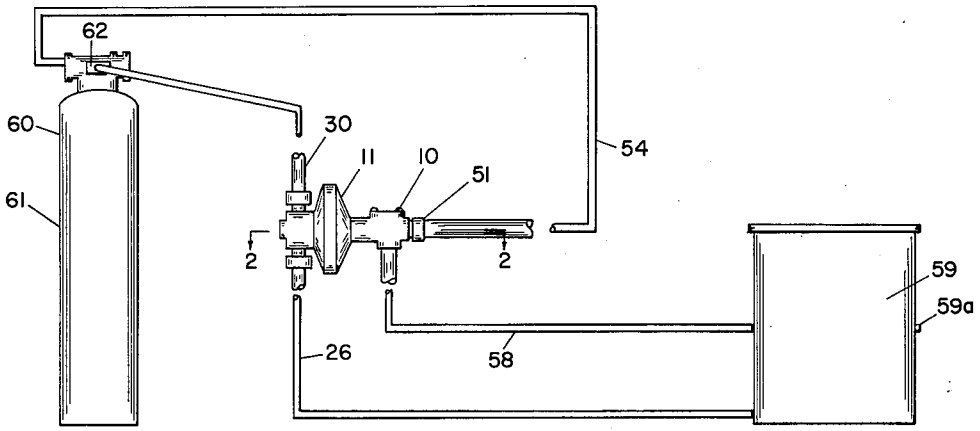


Fig. 1

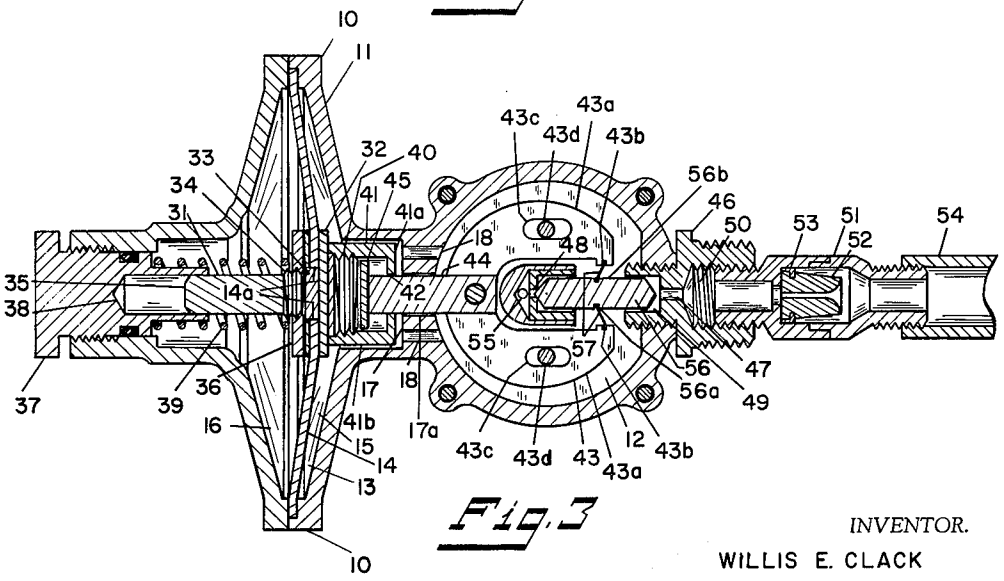


Fig. 3

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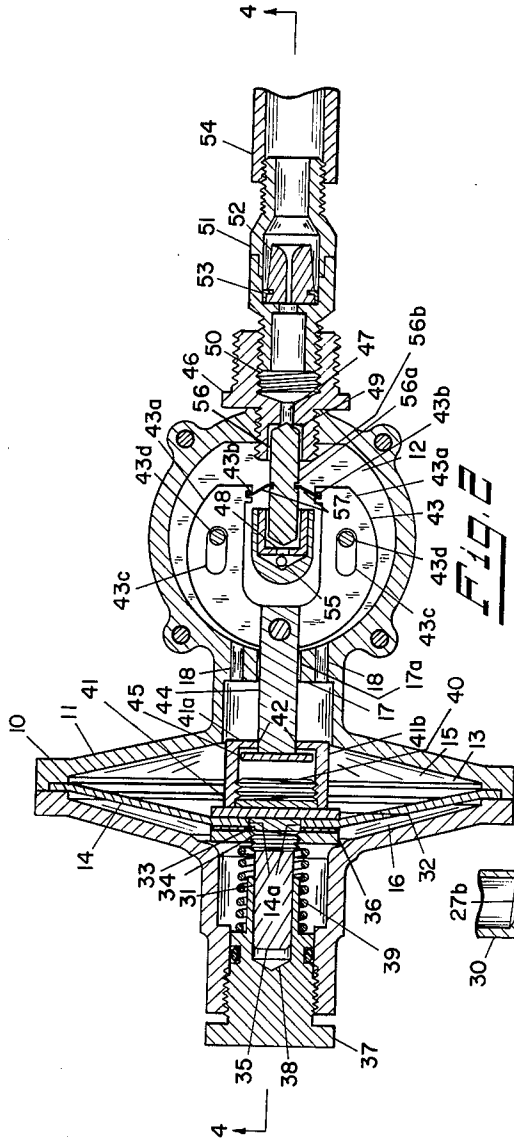


FIG. 2

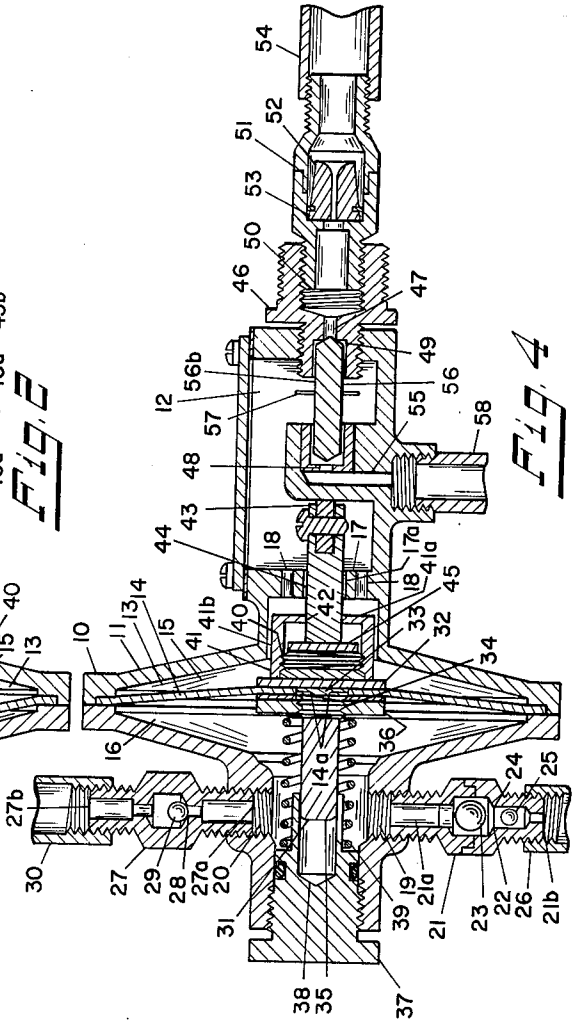


FIG. 4

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PROPORTIONING FLUID PUMP

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2 Claims. (Cl. 103—152)

This invention relates to fluid pumps, and more particularly, to fluid actuated diaphragm pumps.

It is a primary object of my invention to provide a fluid actuated diaphragm pump which will pump an amount of fluid directly proportional to the amount of actuating fluid supplied to the pump.

It is a further object of my invention to provide a compact proportioning fluid pump which has a minimum number of moving parts, is inexpensive to manufacture, and is inherently durable.

Other objects and advantages of my invention will be readily apparent from the following detailed description, taken in conjunction with the accompanying drawings, wherein a preferred embodiment of the invention has been selected for exemplification.

In the drawings:

FIG. 1 is a side elevation view of the proportioning fluid pump of my invention, in use with a schematically shown water softener unit.

FIG. 2 is a horizontal section view taken along section line 2—2 of FIG. 1 and showing the fluid pump of my invention at the beginning of its suction stroke.

FIG. 3 is a horizontal section view taken along the same section line as FIG. 2 and showing the fluid pump of my invention at the beginning of its pumping stroke.

FIG. 4 is a vertical section view taken along section line 4—4 of FIG. 2 and showing the fluid pump of my invention during its suction stroke.

Referring more particularly to the drawings, in which like reference numbers refer to like parts, it is seen that my proportioning fluid pump **10** includes a casing **11**, having a pressure chamber **12** and a diaphragm chamber **13** containing a flexible diaphragm **14**. The diaphragm **14** engages the casing **11** at the periphery of the diaphragm chamber **13** in substantially fluid tight relation to divide the diaphragm chamber into a pressure compartment **15** and a displacement compartment **16**. The pressure compartment **15** communicates with the pressure chamber **12** through the wall ports **18** in the dividing wall **17**. The displacement compartment **16** has an inlet **19** and an outlet **20**.

The inlet **19** is threaded to engage the outlet end **21***b* of the inlet check valve housing **21** in fluid tight relation, as shown. The inlet check valve housing **21** preferably has an upper valve seat **22** adapted to seat an upper ball check **23**, and a lower valve seat **24** adapted to seat a lower ball check **25**. The inlet end **21***a* of the inlet check valve housing **21** is threaded for attachment to an inlet conduit **26** leading to a source of fluid.

The displacement compartment outlet **20** is threaded to engage the inlet end **27***a* of the outlet check valve housing **27** in fluid-tight relation, as shown. The outlet check valve housing **27** has a valve seat **28** adapted to seat a ball check **29**. The outlet end **27***b* of the outlet check valve housing **27** is threaded for attachment to an outlet conduit **30** through which the fluid being pumped is discharged.

The flexible diaphragm **14** has a center hole **14***a* through which the diaphragm alignment stem **31** extends. The alignment stem **31** has a head **32** which bears against the diaphragm **14**, a shoulder **33** of approximately the same width as the diaphragm **14** and which lies within the diaphragm center hole **14***a*, a threaded portion **34** which engages a retainer nut **36** that bears against the side of the diaphragm **14** opposite the head **32**, and an

extended portion **35**. The extended portion **35** engages the guide hole **38** of the diaphragm adjusting screw **37** in slidable relation. A compression spring **39** extends between the adjusting screw **37** and the retainer nut **36** to urge the diaphragm **14** in the direction of the dividing wall **17**.

A threaded stud **40** extends from the alignment stem head **32** in the direction of the dividing wall **17**. A cylinder **41** is threadedly attached to the stud **40** as shown. The cylinder **41** has a closed end **41***a* with a hole **42** through which the connecting stem **44** of U-slide **43** extends. A piston **45** is connected to the end of the connecting stem **44** and is adapted to move back and forth within the cylinder **41**. Movement of the piston **45** within the cylinder **41** is limited in one direction by the stud **40**, and in the other direction by the closed end **41***a* of the cylinder. The connecting stem **44** of the U-slide **43** extends through the stem hole **17***a* in the dividing wall **17** and into the pressure chamber **12**, where it is attached to the U-slide **43** in any suitable manner.

An inlet fitting **46** threadedly engages the casing **11** in fluid-tight relation and extends into the pressure chamber **12**, as shown. The inlet fitting **46** has an inlet port **47**, which is located in alignment with an outlet port **48** located within the pressure chamber **12**. The inlet port **47** connects the inlet fitting alignment passage **49** which extends into the pressure chamber **12**, with the inlet fitting inlet pasage **50**. A flow control body **51**, having a flow control insert **52** retained therein by means of a retainer collar **53**, is preferably attached to the inlet fitting **46** in communication with the inlet passage **50**. The flow control body **51** is in turn connected to a source of actuating fluid, preferably a supply pipe **54**, as shown. The outlet port **48** is preferably a replaceable item which is supported within the pressure chamber **12** in communication with the pressure chamber outlet passage **55**, as shown.

A needle valve **56** is located between the inlet port **47** and the outlet port **48**, and is shiftable between the position shown in FIG. 2, wherein it engages and closes the inlet port **47**, and the position shown in FIG. 3, wherein it engages and closes the outlet port **48**. A pair of snap springs **57** extend between and engage slots **56***a* in the needle valve **56** and slots **43***b* in the opposed legs **43***a* of the U-slide **43**. The legs **43***a* extend on each side of the needle valve **56**, as shown, and are preferably retained in the correct lateral position by bolts **43***d* which extend through guide holes **43***c* in legs **43***a*. The normal extended length of the snap springs **57** is greater than the perpendicular distance between the needle valve **56** and the U-slide opposed legs **43***a*, so that the snap springs **57** will tend to displace the slots **56***a* of the needle valve as great a distance as possible from the slots **43***b* of the U-slide legs **43***a*. Thus, as the U-slide moves from the position of FIG. 2 to the position of FIG. 3, the needle valve **56** will be forced by the snap springs **57** against the inlet port **47** until the slots **56***a* and **43***b* in which the snap springs **57** are engaged are directly opposite each other and the snap springs **57** are compressed to their shortest length. Then, as the U-slide **43** continues toward the position of FIG. 3, the snap springs **57** will exert a force upon the needle valve slots **56***a* in the opposite direction and cause the needle valve **56** to shift to the position of FIG. 3, wherein it is forced against the outlet port **48**.

The operation of my proportioning fluid pump **10** may now be described in detail. Referring to FIG. 1, it will be assumed for the purposes of this description that my proportioning pump **10** is being used to pump brine from the brine tank **59** to the mineral tank **61** of a conventional automatic water softener unit **60** to regenerate the mineral in the mineral tank **61**. My brine pump **10** also replaces with an equal or slightly greater amount of water the brine which is removed from the brine tank **59**. In the

schematically shown system of FIG. 1, supply pipe **54** supplies raw water from the main control valve **62** of the water softener unit **60** to the flow control body **51** and inlet port **47** of my invention; raw water outlet pipe **58** delivers raw water from the oulet port **48** and outlet passage **55** of my pump **10** to the upper portion of the brine tank **59**; the pump inlet pipe **26** delivers brine from the bottom of the brine tank **59** to the pump inlet check valve housing **21**; and, the pump outlet pipe **30** delivers brine from the pump outlet check valve housing **27** to the mineral tank **61**.

During the normal "service" operation of the water softener unit, there is no call for brine from the brine tank **59**. During this period, the pump **10** remains in the position shown in FIG. 3. Although the inlet port **47** is open, no water is supplied to the supply pipe **54** by the water softener unit control valve **62**, and the pump **10** will not operate.

Periodically, however, it is necessary to "regenerate" the mineral material contained in the mineral tank **61** of the softener unit **60** to renew its water softening capabilities. This is conventionally done by passing a solution of salt brine through the mineral tank **61** until the mineral has been regenerated. In the described system, regeneration of the mineral bed is commenced when the control valve **62**, which is normally solenoid operated or motor driven, connects the supply pipe **54** with a raw water supply line (not shown). Raw water (actuating fluid) is then forced through the flow control insert **52** and inlet port **47**, past flats **56***b* on the outer circumference of the needle valve **56**, and into the pressure chamber **12**. The flow control insert **52** is of conventional design and provides a substantially constant rate of flow despite variations in the supply pipe pressure. As the water fills the pressure chamber **12**, it will flow through the wall ports **18**, past flats **41***b* on the outer circumference of the cylinder **41**, and into the pressure compartment **15** of the diaphragm chamber **13**, where it pushes against the diaphragm **14**. As the force of the water against the diaphragm **14** increases, the diaphragm is pushed to the left, as viewed in FIGS. 2 and 3, to compress the spring **39**. As the diaphragm **14** moves to the left, it forces any brine in the displacement compartment **16** outward through the outlet check valve housing **27** and past the outlet ball check **29** to the pump outlet pipe **30**, the control valve **62** and the mineral tank **61**. During the initial movement of the diaphragm **14** and attached cylinder **41**, the piston **45** and connected elements remain stationery. As the diaphragm **14** nears the end of its travel to the left, the closed end **41***a* of the cylinder **41** engages the piston **45** to pull the piston **45**, the connecting stem **44** and the U-slide **43** in the direction of the diaphragm. When the U-slide legs **43** pass the point at which the slots **43***b* and the needle valve slots **56***a* are directly opposite, and where the snap springs **57** are compressed to their shortest lengths, the snap springs **57** will snap the needle valve **56** to the position shown in FIG. 2, wherein the pressure chamber inlet port **47** is closed and the pressure chamber outlet port **48** is opened.

The opening of the outlet port **48** allows the compressed spring **39** to push diaphragm **14** toward the right, as viewed in FIGS. 2 and 3, and force the water in the pressure compartment **15** to flow around flats **41***b* on the cylinder **41**, through wall ports **18**, past flats **56***b* on the needle valve **56**, and outward through the outlet port **48**, outlet passage **55** and outlet pipe **58** to the top of the brine tank **59**, which is at atmospheric pressure. As the diaphragm **14** is forced to the right by the compression spring **39**, it creates a partial vacuum in the displacement compartment **16**. This partial vacuum seats the outlet ball check **29**, raises the upper and lower ball checks **23** and **25** off their respective seats **22** and **24**, and lifts brine from the bottom of the brine tank **59** through the inlet pipe **26** and valve housing **27** to the displacement compartment **16**.

As is the case when the diaphragm **14** travels to the left to pump brine from the displacement compartment **16**, the piston **45** and attached elements remain stationery during the initial movement of the diaphragm toward the right to suck brine into the displacement compartment and exhaust raw water into the brine tank. As the diaphragm **14** nears the end of its travel to the right, the stud **40** engages the piston **45** to push the piston, the connecting stem **44** and the U-slide toward the right to the position shown in FIG. 3. When the U-slide legs **43** pass the point at which the slots **43***b* and the needle valve slots **56***a* are directly opposite, and where the snap springs **57** are compressed to their shortest lengths, the snap springs **57** will snap the needle valve **56** to the position shown in FIG. 3, wherein the outlet port **48** is closed and the inlet port **47** is open to admit water from the supply pipe **54** to the pressure chamber **12**. This will end the movement of the diaphragm **14** and U-slide **43** to the right, and will allow the raw water to again move the diaphragm toward the left to force the brine in the diaphragm chamber **16** outward past the outlet ball check **29** to the outlet pipe **30**.

The above described cycle will be continually repeated to pump brine from the brine tank **59** to the mineral tank **61**, and to replace the brine removed from the brine tank with raw water, until the supply of raw water to the supply pipe **54** is cut off by the control valve **62**. During that portion of the cycle when the inlet port **47** is open to admit raw water to the pressure chamber **12** and pressure compartment **15** and force the diaphragm **14** to the left as viewed in the drawings, which may be designated the "pumping stroke," brine is pumped from the displacement compartment **16** through the pump outlet pipe **30**, the control valve **62** and the mineral tank **61**. During that portion of the cycle when the inlet port **47** is closed and the outlet port **48** is open to exhaust the raw water from the pump **10** to the top of the brine tank **59**, which may be designated the "suction stroke," the diaphragm is forced to the right as viewed in the drawings by the compressed spring **39** to create a partial vacuum in the displacement chamber **16** and draw brine from the bottom of the brine tank **59** to the displacement chamber **16**. Thus, brine is drawn from the brine tank **59** to the displacement chamber **16** during each suction stroke, and is forced from the displacement chamber **16** to the mineral tank **61** during each pumping stroke.

The raw water which is exhausted to the upper portion of the brine tank **59** is less dense than the brine in the lower part of the brine tank **59**, and will float on top of the brine until the brine has all been drawn from the brine tank **59**. My proportioning pump **10** is preferably so constructed that the amount of raw water which is exhausted into the brine tank **59** slightly exceeds the amount of brine pumped from the tank. The raw water remains in the brine tank after the operation of the pump **10** ceases and the softener unit **60** returns to service, where it dissolves salt contained in the brine tank to form a new charge of brine. The slight excess of raw water exhausted into the brine tank **59** allows for evaporation during service and compensates for brine lost through any other causes. The brine tank **59** preferably has an overflow drain **59***a* which limits the amount of brine in the tank **59** and allows any excess water to drain off. My pump **10** can, of course, be easily modified to increase or decrease the amount by which the exhausted fluid exceeds the pumped fluid.

The water softener unit control valve **62** is normally operated by an electric timer mechanism. The timer may be set so that the control valve **62** will supply raw water to operate my brine pump **10** for only as long as it takes the pump **10** to pump all of the brine in the brine tank **59** through the mineral tank **61**. However, it will often be desirable to supply raw water to the pump **10** for a period of time after the brine has been removed from

the brine tank and pumped through the mineral tank **61** to effect a slow raw water rinse of the mineral bed. In such a case, my pump **10** will continue its operation to pump raw water from the brine tank **59** to the mineral tank **61** at the same rate that the brine was pumped to the mineral tank **61**.

The pumping rate of my proportioning pump is dependent upon several factors. The duration of the pumping stroke is primarily governed by the flow rate of the flow control insert **52**. If the flow rate is relatively low, the time required for the raw water passing through the insert **52** to fill the pressure chamber **12** and pressure compartment **15**, and force the diaphragm to the position illustrated in FIG. 2 will be quite great. Conversely, if the flow rate is greater, the time requirement will be less.

The duration of the suction stroke depends mainly upon the strength and amount of compression of spring **39**, and the size of the pressure chamber outlet port **48**. If a relatively strong spring is used, or the diaphragm adjusting screw is tightened to increase the compression of the spring **39**, the spring will force the diaphragm to the position of FIG. 3 more quickly. Similarly, if the diameter of the outlet port **48** is relatively large, it will enable the spring **39** and diaphragm **14** to exhaust the raw water more quickly. Conversely, if the spring **39** is weak, or under less tension, or the outlet port is relatively small, more time will be required for completion of the suction stroke.

There are, of course, many possible modifications of my proportioning pump which will be readily apparent to those skilled in the art. A single ball check valve may be employed at the displacement compartment inlet **19** instead of the upper and lower ball checks **23** and **25** described. The flow control insert **52** may be eliminated, especially where the pressure in the supply line **54** can be expected to be substantially constant, and the size of the inlet port may be selected to provide the desired pumping stroke duration.

My proportioning pump **10** has many uses other than the described use in connection with a water softener unit. My pump **10** may be employed wherever it is desired to pump fluids and there is a source of actuating fluid to operate the pump. It is especially well-suited where it is desired to pump a given amount of one fluid and replace it with or simultaneously meter a proportionate amount of another similar or dissimilar fluid.

It is to be understood that the present invention is not confined to the particular construction, arrangement of parts or methods herein illustrated and described, but embraces all such modifications and alterations thereof as may come within the scope of the following claims.

I claim:

1. In a diaphragm pump having a displacement compartment, an inlet and an outlet in communication with said displacement compartment, first and second check valve means located in said inlet and said outlet, respectively, a flexible diaphragm movable between a first position which maximizes the volume of said displacement compartment and a second position which minimizes the volume of said displacement compartment, and spring means adapted to urge said diaphragm toward said first position, pump actuating and control means comprising,

(a) a pressure chamber in communication with said diaphragm and having an inlet and an outlet,

(b) a unitary valve member located within said pressure chamber and being movable between a first position wherein it closes said pressure chamber outlet and said pressure chamber inlet is open and a second position wherein it closes said pressure chamber inlet and said pressure chamber outlet is open,

(c) slide means extending from said pressure chamber toward said diaphragm and having a first position and a second position,

(d) means attached to said diaphragm for engaging and shifting said slide means to its first position when said diaphragm is moved to its first position, and for engaging and shifting said slide means to its second position when said diaphragm is moved to its second position,

(e) the portion of said slide means which is located within said pressure chamber being substantially U-shaped and having a pair of legs which extend on opposite sides of said valve member in spaced relation, and

(f) snap spring means comprising a pair of compression springs extending from said valve member to each of said slide means legs, respectively, in partially compressed relation, said spring being positioned such that they will displace said valve member in a direction opposite to the direction of travel of said slide means whereby to move said valve member to its first position when said slide means is shifted to its first position, and to move said valve member to its second position when said slide means is shifted to its second position.

2. The invention described in claim **1** wherein the pressure chamber inlet includes flow control means for maintaining a substantially constant rate of fluid flow into the pressure chamber when the valve member is in its first position, despite changes in inlet fluid supply pressure.

References Cited by the Examiner

UNITED STATES PATENTS

1,067,613	7/13	Lane	103—152
3,075,468	1/63	Eifel	103—230 X

FOREIGN PATENTS

296,073	3/28	Great Britain.
524,055	7/40	Great Britain.

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