

[54] SEQUENTIAL INJECTION SYRINGE

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2,567,001	9/1951	Watson .....	128/218 M
2,687,728	8/1954	Copen.....	128/218 D
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3,200,813	8/1965	Christakis .....	128/218 R X

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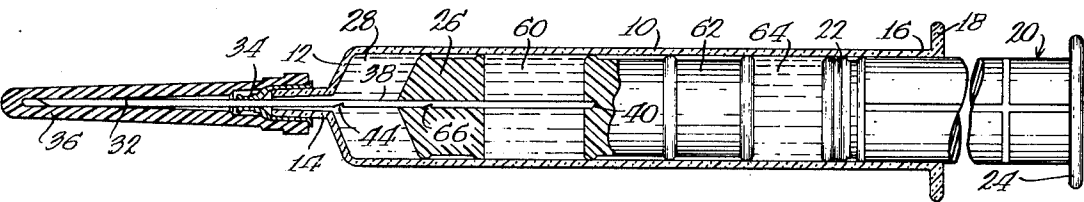
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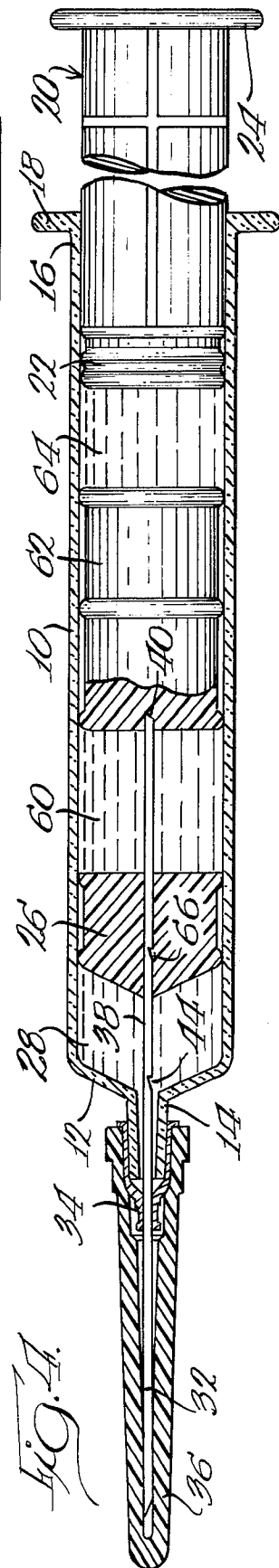
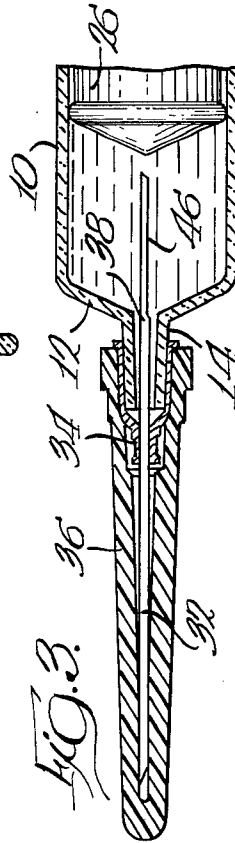
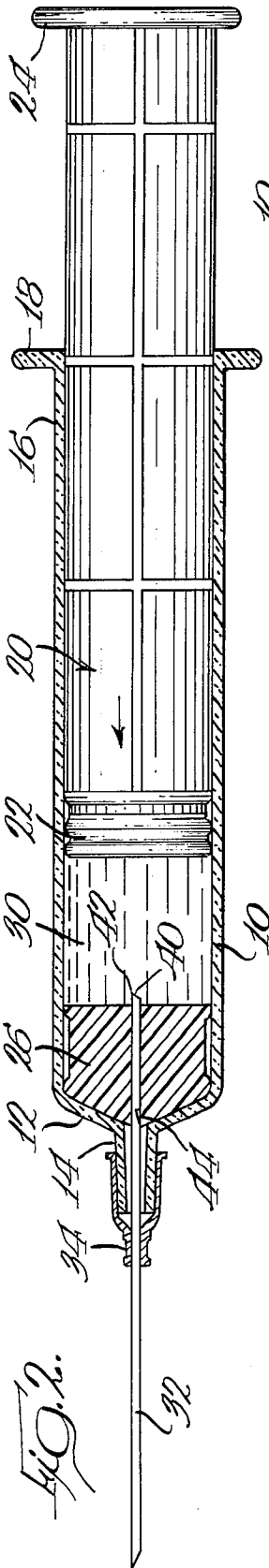
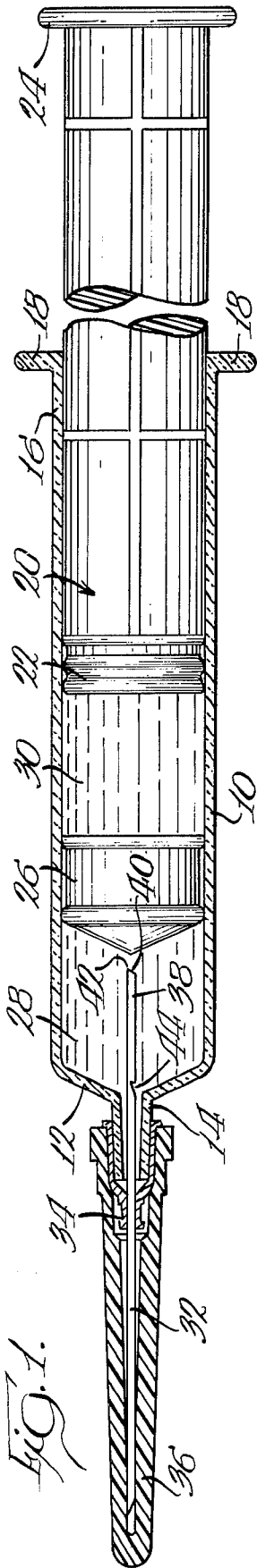
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[57] ABSTRACT

A sequential injection syringe for injecting two or more different types of medicaments sequentially and without intermixing of the medicaments within the syringe during the injection process. The syringe includes a barrel receiving a plunger and one or more independently movable plugs which are separated within the barrel, and between themselves, the distal end of the barrel and the plunger defining two or more medicament receiving spaces. Extending into the barrel from the distal end thereof is a medicament conduit which is open at its innermost end and adapted to pass through the plug or plugs. Immediately adjacent the distal end of the barrel is an opening in the medicament conduit and the inward extension of the conduit is just slightly greater than the thickness of the plug or plugs.

3 Claims, 4 Drawing Figures





## SEQUENTIAL INJECTION SYRINGE

### BACKGROUND OF THE INVENTION

This invention relates to sequential injection syringes, and more particularly, to sequential injection syringes that provide for sequential injection of two or more differing medicaments without substantial intermixing of the medicaments during the injection process.

Frequently during the treatment of a patient, or during immunization procedures, it is necessary or convenient to inject a plurality of different medicaments into the patient at a single time. On such occasions, the administering physician or nurse has frequently administered the multiple injections with an equal number of syringes thereby requiring multiple punctures of the patient.

Such multiple punctures are obviously quite irksome to the patient and if sufficiently so, the patient's ire may be communicated to the administrator resulting in the administrator of the injections becoming increasingly distracted, sometimes to the extent that the ire of the patient is further increased.

In order to solve this problem, the prior art has suggested the use of multiple-injection syringes. One prior construction is illustrated in U.S. Pat. No. 2,687,728 to Copën. According to Copën's teaching, a syringe is provided with a barrel having an inwardly projecting medicament conduit terminating in a sharp point and which is adapted to pierce a plug separating two medicaments within the syringe at a point about half-way through the injection of the first medicament. Use of such a syringe results in intermixing of the two separate medicaments within the syringe during the injection process which, in many instances, is undesirable depending upon the nature of the two medicaments employed.

Another form of multiple-injection syringe is disclosed by Lazarte et al in U.S. Pat. No. 2,939,459. While a construction of a syringe according to Lazarte precludes undesirable mixing of the two medicaments during the injection process, it is extremely unwieldy both in terms of its construction and in terms of its use. For example, the same is essentially two complete syringes with but a single cannula and this is more expensive to fabricate than the usual syringe. And, in order to effect proper operation during the injection process, it is necessary to halt the injection process after the injection of the first medicament to adjust the position of the cannula with respect to the syringe barrel preliminary to the injection of the second medicament. Such adjustment, while the cannula is still in the patient, may well be more bothersome to the particular patient involved than receiving multiple punctures.

While the above-identified patents constitute the most pertinent prior art known to applicant in the multiple-injection syringe field, reference may also be made to Christakis Pat. No. 3,200,813 which relates to an aspirating syringe wherein a saline solution is first injected into a patient and thereafter, and without withdrawing the cannula, the same syringe is employed to withdraw a sample of fat globules or the like for subsequent analysis.

### SUMMARY OF THE INVENTION

It is the principal object of the invention to provide a new and improved sequential injection syringe. More

specifically, it is an object of the invention to provide such a syringe wherein intermixing of different medicaments within the syringe during the ejection process is precluded; which is simple in construction thereby permitting the same to be manufactured at an economical cost; and which does not require anything more than the usual manipulation of a syringe during an injection process.

The exemplary embodiment of the invention achieves the foregoing objects in a construction including a syringe barrel provided with a plunger. Within the barrel are one or more plugs which serve, in conjunction with a cannula receiving end of the barrel and a plunger, to define at least two medicament receiving compartments.

Projecting inwardly into the barrel from the cannula receiving end thereof is a medicament conduit which is adapted to be in fluid communication with the cannula. In the exemplary embodiment, it is integral with the cannula.

The medicament conduit includes, at its innermost end, a pointed configuration for piercing the plugs as well as an opening into which medicament may be introduced into the conduit. The conduit further includes an opening at least at a location adjacent the cannula receiving end of the barrel and the inward extension is of such a length as to be just slightly greater than the width of the plug or plugs. As a result, once the plunger is actuated, the pressure applied by the same to a medicament is relayed to the plug which forces the same to move toward the medicament conduit. The latter pierces the plug while the movement of the plug additionally forces one medicament into the patient through the opening in the medicament conduit adjacent the cannula receiving end of the barrel.

At a time when the innermost end of the conduit begins to emerge from the remote side of the plug, the first medicament will be exhausted from the cannula and continued pressure on the plunger will then drive the second medicament into the patient. Because during the delivery of the first medicament, the innermost end of the conduit will be within the plug, and only the first medicament will be in communication with the opening into the conduit, no intermixing occurs within the syringe.

As inferred above, there is also disclosed a construction wherein three or more different types of medicament may be sequentially injected into a patient.

Other objects and advantages of the invention will become apparent from the following specification taken in conjunction with the accompanying drawings.

### DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross section of a sequential injection syringe made according to the invention prior to the injection process;

FIG. 2 is a cross section of the syringe at a point in the injection process whereat the first medicament has been delivered completely and the delivery of the second medicament has just been initiated;

FIG. 3 is a fragmentary cross section illustrating a modification of the syringe illustrated in FIGS. 1 and 2; and

FIG. 4 is a cross sectional view of a sequential injection syringe for injecting more than two different types of medicaments.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

An exemplary embodiment of a sequential injection syringe made according to the invention is illustrated in FIG. 1 and is seen to include a syringe barrel 10 having a distal end 12 provided with a reduced section 14 defining cannula receiving means and a proximal end 16 terminating in outwardly extending flanges 18 which serve as gripping portions.

Within the barrel 10 is a plunger assembly, generally designated 20, provided with a piston 22 at one end thereof. The other end of the plunger assembly 20 extends from the proximal end 16 of the barrel 10 to terminate in an operating portion 24.

Within the barrel 10 between the distal end 12 and the piston 22 is a grommet or plug 26 which divides the interior of the barrel 10 into a first medicament receiving space 28 and a second medicament receiving space 30. The plug 26 is formed of any suitable material having sufficient resilience as to sealingly engage the interior surface of the barrel 10, which is inert to the medicaments received in the spaces 28 and 30, and which may be pierced relatively easily.

The syringe further includes a cannula 32 secured to a hub 34 which in turn is received on the cannula receiving end of the barrel 10. It is to be understood that the cannula 32 may be mounted directly in the reduced section 14 of the syringe 10 and may be crimped, cemented or otherwise fastened in said hub 34 or in said reduced section 14. Prior to use, the cannula 32 may be protected by an elongated shield 36 formed of rubber or the like and received on the hub 34.

The syringe is completed by a medicament conduit 38 extending inwardly from the distal end 12 of the barrel 10. As is apparent from FIGS. 1 and 2, the medicament conduit 38 according to the preferred embodiment is integral with the cannula 32, comprising an oppositely directed end thereof. It is to be understood that the conduit 38 may be rigidly mounted in the reduced end 14 and projects into said syringe barrel. The cannula 32 may be a needle separate from the conduit 38 and be mounted in a hub 34 which is removable from the distal end of the reduced portion 14 of the syringe. In other words, cannula 32 and conduit 38 may be one piece, as shown, or two pieces each one being separately mounted, as recited, without departing from the spirit of this invention. The medicament conduit 38 is therefore a hollow tube and its innermost end terminates in an opening as at 40 into which the medicament may flow to be conducted to the cannula 32 for injection into the patient. The innermost end of the medicament conduit 38 is further pointed as at 42 for the purpose of puncturing the plug 26 to permit the latter to advance toward the distal end 12 of the barrel 10 under circumstances to be described in greater detail hereinafter.

The medicament conduit 38 is provided with an opening 44 immediately adjacent the distal end 12 of the barrel 10. According to the embodiment illustrated in FIGS. 1 and 2, the opening 44 is in the form of an aperture in the side of the conduit 38. Finally, the length of the inward extension of the conduit 38 within the barrel 10 is just slightly greater than the width of the plug 26.

Operation of the embodiment illustrated in FIGS. 1 and 2 is as follows. Initially, the shield 36 is removed

and the cannula 32 inserted into the patient. Thereupon, the grasping portion 18 is held in the fingers in the usual fashion and pressure to the piston 22 is applied through the plunger assembly 20 by the thumb against the operating portion 24 thereof. Since the liquid medicament in the spaces 28 and 30 will generally be regarded as incompressible, pressure applied to the medicament in the space 30 will be transmitted to the plug 26 which in turn will transmit the pressure to the medicament in the space 28. As the latter is free to flow to the cannula 32 through the openings 40 and 44, the result will be that the plunger 20 will move to the left as shown in FIGS. 1 and 2, as will the plug 26.

When the plug 26 encounters the innermost end of the conduit 36, the pointed end 42 of the latter will pierce the plug 26 and enter the same so as to preclude the flow of medicament to the cannula from the opening 40, the latter being buried within the plug 26. However, medicament in the space 28 will continue to flow to the cannula 32 through the opening 44 and this process will continue until the plug 26 seats against the distal end 12 of the barrel 10. At approximately the same time, as illustrated in FIG. 2, the innermost end of the conduit 38 will emerge from the proximal side of the plug 26 to establish fluid communication to the cannula 32 from the medicament receiving space 30, which has now been shifted toward the distal end of the assembly. Continued application of pressure on the plunger assembly 20 will result in the medicament within the space 30 passing through the cannula 32 into the patient until the piston 22 seats against the proximal side of the plug 26.

From the foregoing, it will be appreciated that the device may be operated in the same fashion as a conventional syringe and that the introduction of the two different medicaments is sequential and without intermixing of the two medicaments within the syringe.

Turning now to FIG. 3, the same illustrates an alternate form of the embodiment illustrated in FIGS. 1 and 2 and in particular, the same is identical to the embodiment illustrated in FIGS. 1 and 2 except that the opening 44 is replaced by an elongated slot in the side of the conduit 38. As illustrated, the slot 46 has its distal end at the same location as the aperture 44 and extends along the side of the conduit fully to the innermost end thereof. A consideration of the above-described mode of operation will indicate that it is the same for either embodiment with the embodiment illustrated in FIG. 3 providing the possible advantage of less resistance to the flow of the medicament from the space 28 by reason of the greater size of the opening communicating therewith.

FIG. 4 illustrates still another embodiment of the invention which is specifically illustrated as accommodating three different types of medicaments but by employing the principles thereof could be, if desired, expanded to provide for sequential injection of an even greater number of different medicaments.

As will be appreciated from a comparison of the embodiment shown in FIGS. 1 and 2 and that illustrated in FIG. 4, most of the component parts of the former are usable in the latter and accordingly will be designated by the same reference numerals in conjunction with the description of the embodiment of FIG. 4.

The differences in construction are as follows. In order to accommodate a greater number of medicaments, the barrel 10 of the syringe should be of an ap-

appropriate length to accommodate the number and volume of medicaments. Within the barrel 10 there is a first medicament receiving space 28 defined by the distal end 12 of the barrel 10 and a plug 26. A second medicament receiving space 60, corresponding approximately to the medicament receiving space 30 in the FIG. 1 embodiment, is defined by the plug 26 and a second plug 62. The latter, in conjunction with the piston 22 defines a third medicament receiving space 64.

The conduit 38 employed in the embodiment illustrated in FIG. 4 extends a far greater distance into the barrel 10 than in the embodiment illustrated in FIGS. 1 and 2 and further includes, in addition to the openings 40 and 44, a third opening 66. According to the embodiment illustrated in FIG. 4, the openings 40 and 66 are embedded within the plugs 62 and 26 respectively.

The distance between the opening 44 and the opening 66 is just slightly greater than the thickness of the plug 26 while the distance between the opening 66 and the opening 40 is equal to the sum of the width of medicament receiving spaces 28 and 60 which in turn is equal to the width of the plug 62 as well. Thus, in operation, it will be appreciated that when pressure is applied to the plunger assembly 20, both of the plugs 26 and 62 will advance on the conduit 38 while the medicament from the space 28 is driven out through the cannula 32. Approximately as the plug 26 seats against the distal end 12 of the barrel 10, the opening 66 will be in communication with the now shifted medicament receiving space 60 and continued pressure on the pressure assembly will drive the medicament from that space through the cannula 32. At this time, however, the opening 40 will still be embedded within the plug 62 because of its greater length and only when the plug 62 seats against the proximal end of the plug 26 will the opening 40 emerge from the proximal end of the plug 62 to permit the medicament from the shifted space 64 to pass through the cannula 32 to the patient. Thus, the embodiment is capable of administering three different types of medicaments with a single puncture of the patient, a simple operation and without intermixing.

Those skilled in the art will recognize that the principles illustrated and described in conjunction with the embodiment shown in FIG. 4 are not limited to application with a syringe that is capable of administering no more than three doses. That is, the same principles can be applied to syringes capable of administering any number of doses limited only by the practicality of the use of such a syringe.

More particularly, the number of doses to be administered can be expanded if the following relations are used to determine the distance between the openings in the conduit 38 and the width of the plugs within the barrel. In particular, the opening nearest the proximal end of the apparatus in the conduit 38, namely the opening 44, should always be immediately adjacent the distal end of the barrel 10 as illustrated. Moving in the proximal direction, the next opening, as illustrated in FIG. 4, the opening 66, should be spaced from the first opening a distance just slightly greater than the width of the plug nearest the distal end of the syringe, here the plug 26. The distance from the second opening to the third opening should be equal to the sum of the widths of the first two medicament receiving spaces, here the sum of the width of the spaces 28 and 60 and, in turn, the second plug, here the plug 62, should have

a width identical to that spacing. The distance between the third and fourth openings should be equal to the sum of the widths of the first three medicament receiving spaces as should be the width of the third stopper, etc. Expressed in general terms, the spacing between any given pair of openings (other than the first and the second which is fixed as mentioned above) must be equal to the sum of the width of all medicament receiving spaces preceding the location of the proximal most opening in the set. By the same token, the width of any plug other than the first plug, must be equal to the sum of the widths of the preceding medicament receiving spaces.

Using the foregoing relations, the syringe can be expanded indefinitely.

From the foregoing, it will be appreciated that the invention provides an extremely simple sequential injection syringe which prevents, during operation, intermixing of the various medicaments thereby allowing multiple medicament administration through injection with but a single puncture. A syringe according to the invention is hardly more complicated than a conventional one-dose syringe, requiring only one or more plugs (depending upon the total number of different medicaments to be administered) and the provision of the inwardly extending medicament conduit, and therefore, may be constructed very economically.

Moreover, it will be recognized that the principles of the invention are not only applicable to the type of syringe illustrated herein, but cartridge receiving types as well. For example, a pre-packaged cartridge provided with two or more medicaments separated by independently movable plugs could be loaded into the barrel 10 prior to injection if desired. In such a case, it would only be necessary to adjust the position of the openings 40, 44 and 66 in the direction of the piston 22 an amount approximately equal to the thickness of the diaphragm on the end of the cartridge to be received in the distal end of the barrel.

I claim:

1. A sequential injection syringe comprising: means defining a syringe barrel having, at one end, a cannula carried by a cannula receiving means and at the other, a grasping portion; plunger means within said barrel and having a portion extending from the barrel at said other end thereof; at least two separate plugs within said barrel and movable therein independently of said plunger, said plugs being adapted to define a number of medicament receiving compartments one greater than the number of plugs within said barrel, one compartment being between one plug and said one end and one other compartment being between another plug and said plunger; and a medicament conduit integral with the cannula on said cannula receiving means and including a tube-like element extending into said barrel from said one end thereof, the innermost end of said medicament conduit being disposed just within the plug nearest the plunger and being configured to pass through said plug and permit the entry of a medicament into said medicament conduit, said medicament conduit including additional openings intermediate its length within the barrel and equal in number to one less than the number of plugs, one of said openings being immediately adjacent said barrel one end with each additional opening being within one of said plugs, each said additional opening being spaced from the adjacent additional opening nearer said barrel one end a dis-

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tance corresponding approximately to the width of the plug in which it is disposed; the width of each plug being approximately equal to the sum of the lengths of all medicament receiving spaces on the side thereof nearer said barrel one end, the length of said medicament conduit within said barrel being just slightly greater than the sum of the widths of all of said plugs.

2. The sequential injection syringe of claim 1 wherein

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said second opening is in the form of an aperture in the side of said medicament conduit.

3. The sequential injection syringe of claim 1 wherein said second opening is in the form of a slot along one side of said medicament conduit extending from said location immediately adjacent said barrel one end inwardly into said barrel.

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