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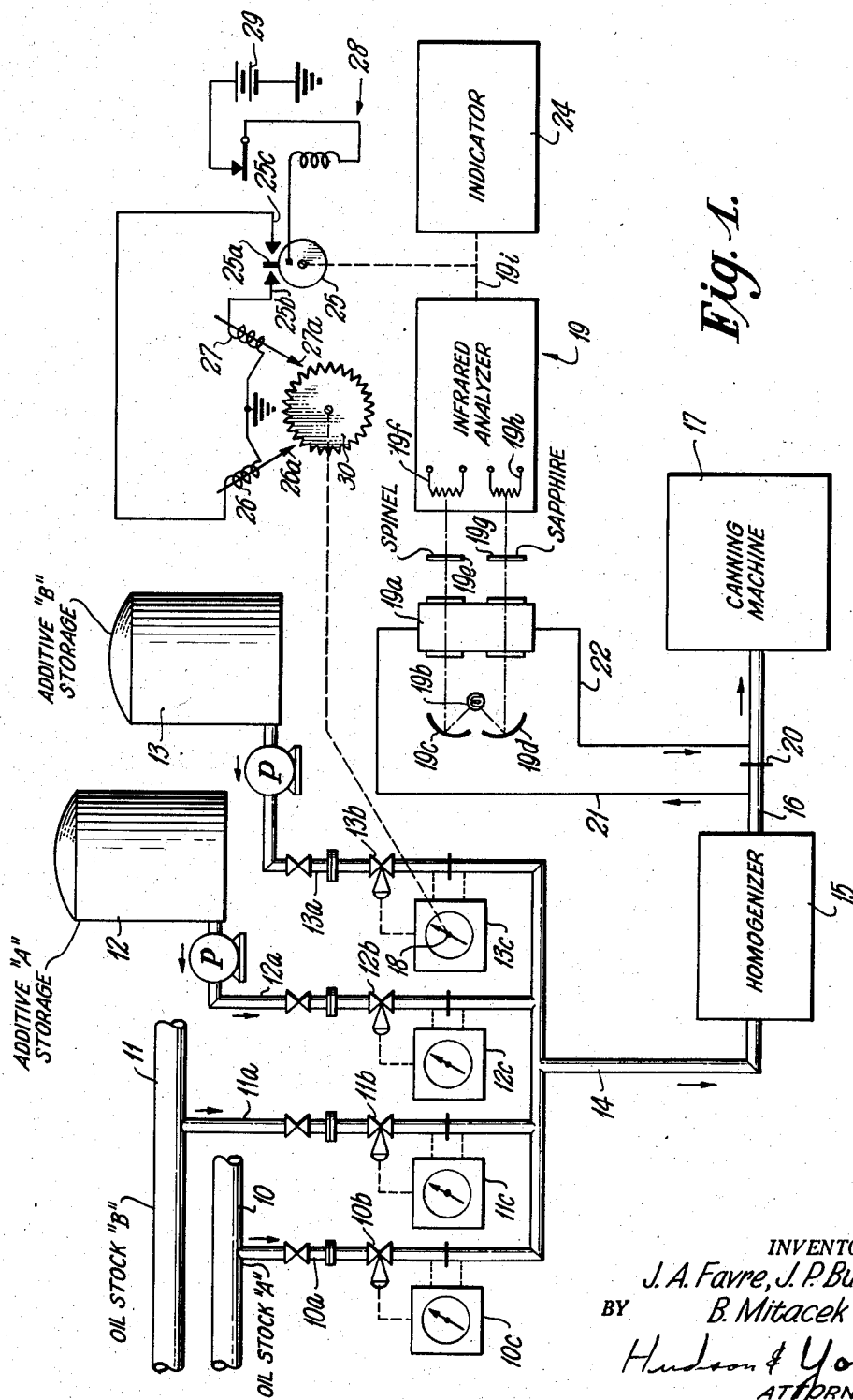
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2,883,343

METHOD AND APPARATUS FOR BLENDING LUBRICATING OIL STOCKS

Filed Sept. 2, 1954

2 Sheets-Sheet 1



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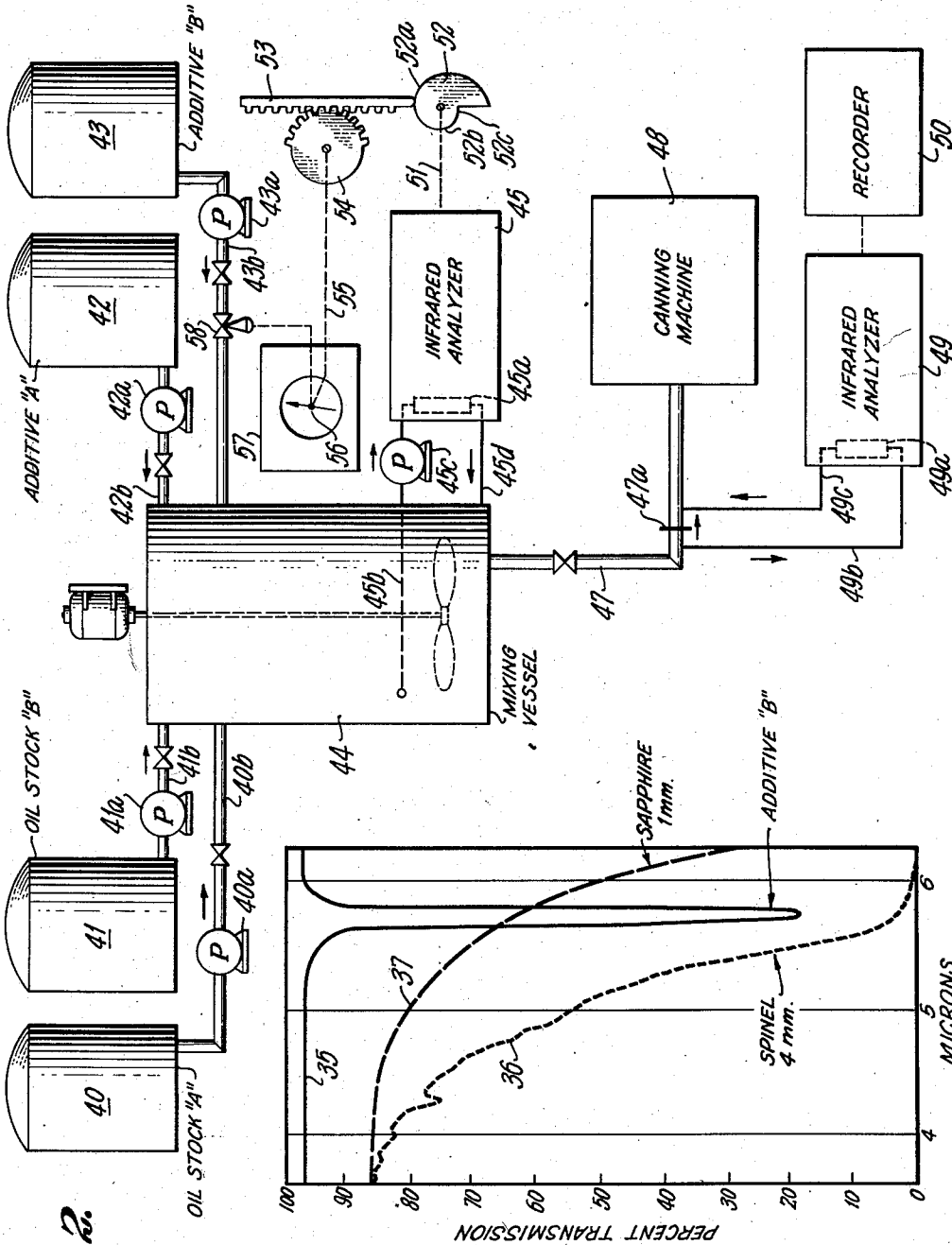


Fig. 2.

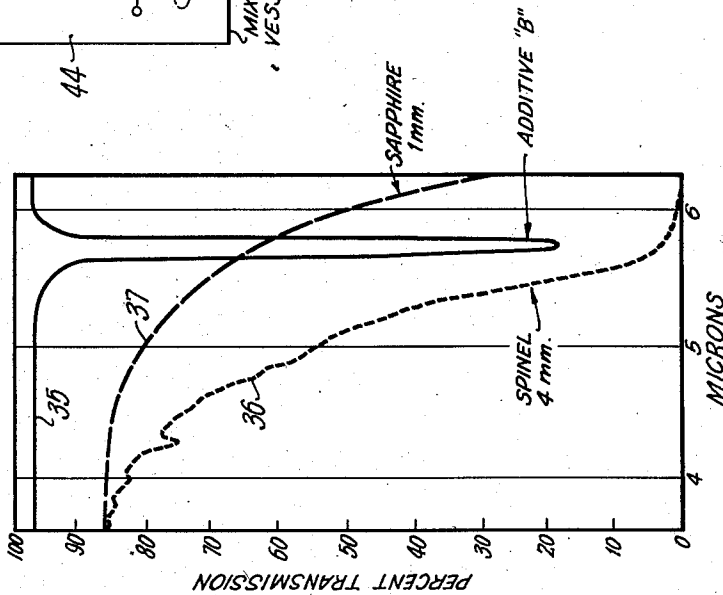


Fig. 3.

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METHOD AND APPARATUS FOR BLENDING LUBRICATING OIL STOCKS

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7 Claims. (Cl. 252—56)

This invention relates to a method of and apparatus for analyzing a lubricating oil stock containing an additive. In another aspect, it relates to a method of and apparatus for controlling the blending of additives with lubricating oil stocks.

In the production of lubricating oil stocks of superior quality, additives of various types are commonly added to improve the properties of the oil, for example, to improve the viscosity index of the lubricating oil stock. Of these additives, synthetic oil-soluble polymerized esters of the acrylic acid or the vinyl ester series either alone or copolymerized with monohydric primary saturated aliphatic alcohols are of particular value. However, the cost of these and other additives is rather high. Consequently, in order to secure economical operation, it is quite important that the concentration of additive in the oil be carefully controlled so as to secure the requisite improvement in lubricating oil properties without wasting the valuable additives.

In accordance with this invention, the amount of additive is accurately determined and controlled by passing a beam of infrared radiation through the stock and producing an output representative of beam intensity after it has passed through the sample. Where the additive has a definite characteristic absorption band, the beam output is representative of the additive concentration in the lubricating oil stock. In particular, in the case of the specific polymerized esters mentioned above, there is a strong absorption band in the wave length region of 5.5 to 6.1 microns. Accordingly, by sensitizing the analyzer to this wave length band, the additive concentration is quickly and accurately determined.

Further in accordance with the invention, the analyzer output can be used, in a novel manner, to control either a continuous or batch blending operation to provide high-quality additive-containing lubricating oil stocks with maximum economy in the use of additive.

Accordingly, it is an object of the invention to provide an improved method of and apparatus for analyzing a lubricating oil stock containing an additive by virtue of the radiation-absorption characteristics of such additive.

It is a further object to provide an improved method of and apparatus for controlling an operation where one or more lubricating oil stocks are blended with one or more additives either on a batch or continuous basis.

Various other objects, advantages and features of the invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

Figure 1 is a flow diagram of a continuous blending operation conducted in accordance with the invention;

Figure 2 is a flow diagram of a batch blending operation conducted in accordance with the invention; and

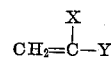
Figure 3 is a graph illustrating the manner of sensitizing an infrared analyzer and analyzing for the presence of a particular additive.

Referring now to Figure 1, we have shown a source

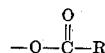
10 of a lubricating oil stock A and a source 11 of an oil stock B. In typical blending operations for producing high quality lubricating oils, two or more such stocks of varying viscosity are blended, together with additives, to form a superior oil. For example, stock A can be a No. 20 oil and stock B can be a No. 50 oil which can either be blended together or with additional amounts of other stocks, such as No. 10 and No. 250 oil.

The blending system also includes a storage vessel 12 for an additive A and a storage vessel 13 for an additive B. In a preferred embodiment of the invention, additive A is a detergent material, such as an alkyl aryl sulfonate, which does not have a radiation absorption band in the 5.5 to 6.1 micron region. Alternatively, additive A can be a mixture (X) of barium phenyl sulfide, calcium sulfonate, zinc alkyl dithiophosphate, and a plasticizer, such as methyl Carbitol. This compound acts as a combined detergent and oxidation inhibitor.

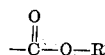
Additive B is a polymer of a compound having the formula



wherein "X" is a hydrogen atom, an alkyl or aromatic hydrocarbon group, and "Y" is



or



in which R is a monovalent hydrocarbon radical containing more than four carbon atoms or an ether derivative of said hydrocarbon radical, either alone or copolymerized with monohydric saturated primary aliphatic alcohols containing from 5 to 18 carbon atoms per molecule. Such additives are described in detail in Patent 2,091,627. They have molecular weights ranging from 2,000 to 100,000 and normally contain less than 30 carbon atoms in the aforementioned hydrocarbon groups and radicals. We have discovered that such additives have a strong infrared absorption band in the 5.5 to 6.1 micron region which, it is our belief, can be attributed to the carbonyl group. Other additives, in many cases, have definite and strong absorption bands at other regions of the spectrum.

Additive B is added to the oil in the proportion of 2 to 8 percent by weight, usually 5 to 6 percent and additive A can be added in amounts of 0.1 to 12.0 percent.

A typical quality oil blend has the following composition

Component	Volume, Percent	Viscosity (SUS at 210° F.)	Viscosity Index
Oil Stock A, 10H.....	1 80	39-40	99-105.5
Oil Stock B, 50H.....	1 20	115-118	97-98
Additive A (Mixture X) ²	2 8.5		
Additive B (Polymerized ester of acrylic acid compound) ⁴	2 5.0		

¹ Of total hydrocarbons.

² Of total blend.

³ Paradox 114.

⁴ Acryloid 710.

The sources 10, 11, 12 and 13 are connected by valved hoses or other conduits 10a to 13a, respectively, to a blending machine having valved conduits 10b to 13b, respectively, which lead to a common outlet conduit 14. The junction between the pipes 10b and 13b and conduit 14 can be regarded as a mixing zone or vessel where the actual blending takes place. The admixed materials are fed through a homogenizer 15, which produces an intimate mixture of the oil stocks and additives, and a pipe

16 to a canning machine 17. In a broad sense, the homogenizer 15 and pipe 16 can be considered part of the mixing vessel or zone for the purposes of withdrawing a sample of material to be analyzed.

The valves in conduits 10b and 13b are connected to and controlled by a set 10c to 13c of rate of flow controllers, respectively, which meter the various streams fed to the mixing zone. The controller 13c has a settable element 18 by which the amount of additive B flowing to the mixing zone can be adjusted.

It will be appreciated that the described system provides a very convenient and effective means for providing desired blends of lubricating oils. Thus, the hoses 10a and 11a can be readily connected to or disconnected from oil stock sources 10, 11 and other oil sources can be applied to the mixing device as desired to select various particular oil stocks for any desired blending operation. Similarly, different additive materials can be chosen for different blends.

In accordance with the invention, a sample of the blend is withdrawn from a portion of the mixing zone, such as pipe 16, and the amount of additive B therein is determined by an infrared analyzer 19. To this end, an orifice 20 is provided in pipe 16 and a sample is withdrawn at the upstream side of the orifice through a sample line 21 whence it passes through a sample cell 19a of the analyzer and, thence, returns to the downstream side of the orifice 20 through a sample line 22.

In the cell 19a, the blended oil stock is traversed by twin beams of infrared radiation from a source 19b which are reflected by mirrors in two paths to the cell 19c and 19d which are provided with windows, formed, for example, from calcium fluoride, which are substantially transparent to the radiation used. One beam passes through a spinel filter 19e to a radiation detector 19f, such as a bolometer, and the other beam passes through a sapphire filter 19g to a second detector or bolometer 19h. The analyzer is sensitized, in the manner hereinafter explained in detail, so that it produces rotation of a shaft 19i in an amount proportional to the quantity of additive B in the lubricating oil blend. Preferably and advantageously, the analyzer can be of the type disclosed in Hutchins Patent 2,579,825 with the inclusion of the particular filters here described.

The shaft 19i is coupled to an indicator 24 which produces a continuous indication of the amount of additive B in the lubricating oil blend, and also to a disk 25 carrying a movable contact element 25a. This element cooperates with a pair of fixed contact points 25b and 25c which are connected, respectively, to solenoid windings 26 and 27. The contact element 25a is connected through the operating winding and a normally closed contact set of a time delay relay 28 to one terminal of a battery 29, the other terminal of which is grounded and thereby connected to both solenoid coils 26 and 27.

The solenoids 26 and 27 are provided, respectively, with pawl members 26a and 27a coacting with the teeth of a ratchet wheel 30. The ratchet wheel 30, in turn, is connected to the settable element 18 of controller 13c.

In the operation of the system, therefore, the analyzer 19 continuously determines the amount of additive B in the lubricating oil blend and this is shown by indicator 24. If the concentration of additive B falls below a predetermined value, shaft 19i rotates and closes a circuit between contacts 25a, 25c. This causes a momentary actuation of solenoid 26 and a resultant stepwise clockwise movement of ratchet wheel 30. Thereupon, settable element 18 is moved to increase the amount of additive B admixed with the blend. After this stepwise movement of ratchet wheel 30, the circuit to solenoid 26 is broken by the opening of the contacts of relay 28. After the time delay period of this relay elapses, its contacts again close and, if the desired proportion of additive is now present in the blend, the circuit between contacts 25a, 25c is broken and no further action takes place. However,

if the additive concentration is still too small, contacts 25a, 25c remain closed and a further stepwise actuation of the ratchet wheel 30 occurs at the expiration of the delay period of relay 28. This delay period is so chosen that the effect of adjusting the flow rate of additive B has time to manifest itself at the analyzer 19 before a further correction is made. This prevents hunting or overshooting the control system and improves the economy of operation.

Conversely, if the additive concentration becomes too high, shaft 19i rotates disk 25 so as to close contacts 25a, 25b. This results in a momentary energization of solenoid 27 and a stepwise counterclockwise movement of ratchet wheel 30 to effect a downward adjustment of the rate of flow of additive B. Relay 28 operates in the same manner as previously described to disable the control system for a predetermined interval until the effect of the first stepwise adjustment is manifested at the analyzer 19.

It will be evident, therefore, that we have provided an efficient rapid acting control system for providing a predetermined amount of additive in a lubricating oil blend which does away with the loss of time heretofore required for analysis of the lubricating oil stock and additive content. Further, due to the use of infrared radiation, the control action is effected independently of the color of the oil stream.

As previously noted, the analyzer 19 is sensitized to the particular additive which is to be controlled. The aforementioned polymerized esters of the acrylic acid or vinyl ester series have a strong absorption band at the 5.5 to 6.1 micron region of the spectrum, as indicated by the line 35 of the graph, Figure 3.

It will be noted that one of the twin beams of infrared radiation passes through a spinel filter 19e having a thickness of 4 millimeters, the absorption characteristics of which in the region of interest are indicated by line 36, Figure 3. The other radiation beam passes through the sapphire filter 19g, which can have a thickness of 1 millimeter. The absorption characteristics of this material are indicated by line 37, Figure 3, in the wave length region of interest. Thus, in the 5.5 to 6.1 micron region, there is a difference in the effect of the additive upon the two beams so that, when the intensity of these beams is electrically compared by the analyzer to produce a resultant output, this output varies in accordance with the concentration of the additive in the system.

At other regions of the spectrum where strong absorption bands are present due to the components of the oil stocks and additive A, the spinel and sapphire filters are equally transparent so that the reading of the instrument is not affected thereby. Consequently, the output of the instrument is a direct measure of the amount of additive B present in the blend. From this, it will be understood that the instrument can be sensitized to other additive materials having one or more strong infrared absorption bands by proper choice of filter media to the end that the additive in question produces a different absorption effect in one beam than in the other beam.

Instead of spinel, a standard sample of lubricating oil, a sample of acetone can be used, or other materials with low transmission in the 5.5 to 6.1 micron band can be used.

Referring now to Figure 2, we have shown a batch type blending system incorporating storage vessels 40, 41, 42 and 43 for oil stock A, oil stock B, additive A, and additive B, respectively. Material is fed from these storage units to a mixing vessel 44 through the respective pumps 40a to 43a and valved lines 40b to 43b.

An infrared analyzer 45 of the type described in connection with Figure 1 has a sample cell 45a, and a sample from the vessel 44 is continuously withdrawn through a sample line 45b, passed through the cell 45a by a pump 45c, and returned to the mixing vessel by a sample line 45d. The analyzer 45, therefore, indicates the proportion of additive B present in the mixing vessel 44.

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The blended oil product is removed from the vessel 44 by a valved conduit 47, which can be considered as forming a part of the mixing zone, and transferred to a canning machine 48. An infrared analyzer 49 has a sample cell 49a to which a sample is admitted from the line 49b on the upstream side of an orifice 47a in the conduit 47, the material returning to the downstream side of the orifice 47a through a sample line 49c. As a result, the analyzer 49 indicates the proportion of additive B in the conduit 47, and the output of the analyzer is fed to a recorder 50 which provides a continuous record of the finished production.

The output of analyzer 45 appears as a rotation of a shaft 51 to which is fixed a cam 52. Cooperating with the face of cam 52 is a rack 53 which is geared to a pinion 54 which, in turn, is connected by a shaft 55 to a settable element 56 of a rate of flow controller 57. The controller 57 is operatively connected to a valve 58 in the conduit 43b, and it is arranged to meter additive B into the mixing vessel 44 at a rate determined by the position of settable element 56.

In operation, the ingredients of the blend, with the exception of additive B, are charged to the mixing vessel 44 in proper amounts to make the desired blend. Thereupon, addition of additive B is started. At this time, rack 53 rests upon a flat portion 52a of the cam 52 and, in this position, settable element 56 controls unit 57 so as to maintain valve 58 in a fully open position, thereby permitting a maximum rate of flow of additive B into the mixing vessel.

As the concentration of additive B increases toward a predetermined value, cam 52 rotates in a clockwise direction responsive to the action of analyzer 45. As this concentration approaches the desired value, a curved face 52b of the cam engages rack 53 with the result that pinion 54 and settable element 56 are actuated so as to gradually decrease the rate of flow of additive B to the mixing vessel. Thus, the addition of the additive proceeds at a slower rate than the initial rate.

As the concentration of additive B reaches the desired value, the continued clockwise rotation of cam 52 causes a flat part 52c of the cam to engage rack 53, thereby moving pinion 54 and settable element 56 so as to stop the flow of additive into the mixing vessel 44.

As a result, additive B is metered into the blend at a rapid rate during the initial stages of its addition. As the desired concentration of additive B is approached, the additive proceeds more and more slowly, and stops when the predetermined value is attained.

Accordingly, with respect to Figure 2, we have shown a simple and accurate method both of monitoring the final product and of controlling the rate of addition of additive B to the mixing vessel to the end that the desired amount is quickly added without danger of adding excessive and uneconomical amounts to the mixture.

While the invention has been described in connection with present, preferred embodiments thereof, it is to be understood that this description is illustrative only and is not intended to limit the invention.

We claim:

1. In a system for continuously blending a lubricating oil stock with an additive, in combination, a source of oil stock A, a source of oil stock B, a storage vessel containing an additive A, a storage vessel containing an additive B which has an infrared absorption band within the 5.5 to 6.1 micron region, means defining a mixing zone, valved conduits connecting said sources and the storage vessel for additive A, respectively, to said mixing zone, rate of flow controllers operatively connected to the respective valves to maintain preset rates of flow through the conduits controlled thereby, a line connecting said storage vessel for additive B to said mixing zone, a valve in said line, a rate of flow controller operatively connected to said valve to maintain a preset rate of flow of additive B to said mixing zone, said controller having a settable ele-

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ment arranged to vary the rate of flow of said additive B, said mixing zone incorporating a homogenizer to secure an intimate mixture of said oil stocks and said additives, an infrared analyzer having a sample cell, means for continuously passing a sample of material from said mixing zone through said cell, means for passing a twin beam of infrared radiation through said cell and the material included therein, a filter in one beam to attenuate radiation within the 5.5 to 6.1 micron region, radiation detector means, and a shaft rotatable by said detector means in accordance with the amount of additive B present in the sample material, a contact member driven by said shaft, a pair of fixed contacts spaced from said contact member whereby rotation of said shaft a predetermined amount in one direction closes a circuit between one fixed contact and said movable contact member while rotation of the shaft a predetermined amount in the opposite direction closes a circuit between said movable contact member and the other fixed contact, an adjusting member connected to said settable element, a solenoid arranged to effect stepwise movement of said adjusting member in one direction, a second solenoid arranged to effect stepwise movement of said adjusting member in the other direction, said solenoids being connected to circuit, respectively, with said fixed contacts, a current source, a time delay relay having an operating winding and a set of normally closed contacts, and means for completing both solenoid circuits through said movable contact member the operating winding and contacts of said relay, and said current source.

2. In a system for effecting batch blending of a lubricating oil stock, a mixing tank, an agitator therein, a source of a lubricating oil stock A and a source of a lubricating oil stock B, a source of an additive A, valved conduits connecting the respective sources to said mixing tank, a source of an additive B having an infrared absorption band within the 5.5 to 6.1 micron region, a valved line connecting said source of additive B to said mixing tank, a rate of flow controller operatively connected to said valve and arranged to maintain a controlled rate of flow through said line, said controller having a settable element to vary said rate of flow, an infrared analyzer sensitive to radiation within the 5.5 to 6.1 micron region, said analyzer having a sampling device connected to said mixing tank, and said analyzer having a rotatable shaft, the angular position of which is representative of the concentration of additive B in the blending vessel, a cam fixed on said shaft, mechanism actuated by said cam to adjust said settable element, said cam having a flat part arranged to maintain a high rate of flow of additive B to the blending vessel when its concentration is substantially below a predetermined value, an angular portion arranged to decrease the rate of flow of additive B as the predetermined concentration is approached, and a second flat portion arranged to shut off the flow of additive B when the concentration thereof reaches said predetermined value.

3. The method of preparing a lubricating oil stock which comprises adding a material containing carboxylic groups as an additive to a lubricating oil stock, intermixing said additive and said stock, passing a beam of infrared radiation through a sample of the intermixed material, producing an electrical output representative of the portion of radiation in the wave length of range of 5.5 to 6.1 microns passing through said sample, said output being proportional to the amount of said additive in said stock, and regulating the relative amounts of additive and stock fed to the admixing step in accordance with said output so as to maintain a fixed concentration of additive in said stock.

4. The method of blending an additive into a lubricating oil stock which comprises introducing a stream of lubricating oil stock and a stream of lubricating oil additives into a mixing zone, continuously withdrawing a sample of the additive-lubricating oil mixture from the

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mixing zone, passing a beam of infrared radiation through the withdrawn sample, producing an output representative of the intensity of said beam after it has passed through said sample, and regulating the rate of flow of one of said streams to the mixing zone in accordance with said output to maintain said output at a constant predetermined value.

5. The method of blending an additive into a lubricating oil stock which comprises introducing a plurality of streams of different lubricating oil stocks and a stream of lubricating oil additive into a mixing zone, continuously withdrawing a sample of the additive-lubricating oil mixture from the mixing zone, passing a beam of infrared radiation through the withdrawn sample, producing an output representative of the intensity of said beam after it has passed through said sample, and regulating the rate of flow of said additive stream to the mixing zone in accordance with said output to maintain said output at a constant predetermined value.

6. The method of continuously blending an additive into a lubricating oil which comprises passing a stream of an oil stock A, a stream of an oil stock B, a stream of an additive A and a stream of an additive B into a mixing zone, said additive B having an infrared absorption band within the 5.5 to 6.1 micron region, maintaining a constant rate of flow of said oil stock A, oil stock B, and said additive A into the mixing zone, homogenizing the mixture of oil stocks and additive within the mixing zone, continuously withdrawing a sample of homogenized material from the mixing zone, passing a beam of infrared radiation through the withdrawn sample, filtering the radiation to provide an output substantially representative of energy within said 5.5 to 6.1 micron region and sub-

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stantially unaffected by radiation outside said region, and controlling the rate of flow of said additive B into the mixing zone in accordance with said output to maintain said output and thus the concentration of additive B at a constant predetermined value.

7. A method of batch blending a lubricating stock which comprises feeding predetermined amounts of a lubricating oil stock A, a lubricating oil stock B, and an additive A to a mixing zone, agitating the mixture in the mixing zone, withdrawing a sample of material from the mixing zone, passing a beam of infrared radiation through the sample, filtering the radiation so as to produce an output sensitive to radiation within the 5.5 to 6.1 micron region and substantially insensitive to radiation outside said region, adding an additive B having an infrared absorption band within the 5.5 to 6.1 micron region to the mixing tank, controlling the rate of flow of said additive B in accordance with said output to cause said additive B to flow into the mixing tank until said output reaches a predetermined value, and thereupon terminating the flow of said additive B to the mixing tank.

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