FEARNS
HORSEPOWER CALCULATOR for VEE BELT DRIVES

INSTRUCTIONS

The design of the calculator is based on British Standard 1440: 1962 (Appendix B, "Recommendations for Power Applications of V-Belts"), and the Horsepower Ratings given by the calculator are in accordance with this. The calculator interpolates more accurately than is possible on certain of the tables in the British Standard however and in some instances this may lead to slight and unimportant differences between the two.

Abridged instructions are engraved on the calculator and these are considered to be quite adequate for normal day-to-day use. The purpose of this leaflet is to provide more detailed information, with examples, which may be of value when the calculator is handled for the first time but unlikely to require frequent reference

It will be noted that the calculator is divided into 5 consecutively numbered sections, 1, 2, 3, 4a & b and 5. Usual procedure when designing or checking the Horsepower Rating of a drive is to start at Section 1. and work consecutively through the sections until the Allowable Horsepower Rating per Belt is determined in section 5. The maximum Allowable Horsepower for the drive is of course this value multiplied by the number of belts in the drive

DESIGNING A V-BELT DRIVE

1. Ascertain the Horsepower of the driving motor, or alternatively the Horsepower required to drive the machine in question, then select an appropriate belt section from Table "A" (on back of calculator case) and also note minimum pulley diameter.
   Alternatively a suitable belt section for given Horsepower requirements may be determined on the calculator—see para. 10, "Using the Calculator for Rapid Approximate Sizing."

2. Determine the Speed Ratio between driving and driven shafts by dividing the speed of the driven shaft into the speed of the motor or driving shaft.

3. Select the pulley diameters to give this ratio. The small pulley diameter must be not less and preferably rather larger than the recommended minimum in Table 'A".

   $$\text{Speed Ratio} = \frac{\text{Diameter of large pulley.}}{\text{Diameter of small pulley.}}$$

   In the case of high speed drives it is usually not desirable for belt speeds to exceed 5,000 feet per minute, and section 4b of the calculator can be used to quickly check belt speed for a given pulley diameter.

4. Select a nominal pulley centre distance. This will of course be determined primarily by space considerations, but generally speaking the greater the centre distance the more favourable the driving conditions and the higher the Horsepower rating permissible.

5. Determine the belt pitch length using section 1. of the calculator and proceeding as follows:—

   (a) Divide Centre Distance "C" by Small Pulley Pitch Diameter "d".

   (b) Set the value thus found, on $\frac{C}{d}$ scale, to Speed Ratio on curves below.

   (c) Read value $\frac{L}{d}$ on outer scale opposite arrow and multiply this by Small Pulley Pitch Diameter "d" to determine Belt Pitch Length "L".

   After determining the calculated Belt Pitch Length as above, the nearest Standard Belt Length can be selected from Table "B" (see back of calculator case), and after selecting a Standard Belt Length the corrected centre distance for the drive can now be found:—

   Use section 1. of the calculator and proceed generally as above but in reverse order.

   (d) Divide Standard Belt Pitch Length "L" by Small Pulley Pitch Diameter "d".

   (e) Set arrow to this value on outer scale.

   (g) Read off $\frac{C}{d}$ value on scale against Speed Ratio on curves below and multiply this by Small Pulley Pitch Diameter "d" to determine correct Centre Distance.

EXAMPLE

A 1440 r.p.m. motor is to drive a machine at 720 r.p.m., Belt Centres to be approximately 30 in. and Small Pulley Pitch Diameter to be 5 in. Find the nearest standard B-section belt and corresponding actual Centre Distance

Speed ratio $= \frac{1440}{720} = 2.0$ Large Pulley Diameter $= 5 \times 2.0 = 10$ in.

Proceeding as above:— Divide centres by Small Pulley Pitch Diameter.

$$= \frac{30}{5} = 6$$

Set 6 on $\frac{C}{d}$ scale to 2 : 1 speed ratio curve.

Read $\frac{L}{d}$ value opposite arrow equals 16.7.

Multiply 16.7 by 5 (Small Pulley Diameter) and Belt Pitch Length equals 83.5 in.

Nearest Standard Belt Pitch Length above this is **86.7 in.**

Now find the actual Centre Distance for the Standard Belt Pitch Length of 86.7 in.:—

Divide Belt Length by Small Pulley Pitch Diameter

$$= \frac{86.7}{5} = 17.34$$

Set $\frac{L}{d}$ arrow to 17.34 and read 6.3 opposite 2 : 1 Speed Ratio curve.

Multiply 6.3 by 5 (Small Pulley Diameter) and actual Centre Distance for Standard Belt Length is **31.5 in.**

6. Having determined Belt Length and Centres the next step is to find the combined Power Correction Factor, using sections 2 and 3:—

Section 2. First find the value (D-d) by subtracting the small pulley pitch diameter from the large one.

Then set this value (D-d) to the Belt Centres and read off the appropriate factor in the window, depending on whether the drive is V-V (i.e. both pulleys with Vee-grooves) or V-Flat (i.e. one pulley only with Vee-grooves). It will also be noted that the Arc of Contact value can be read for information, although this is not needed in the actual Horsepower calculation.

Section 3. Set the cursor over the value of the Arc of Contact Factor (as determined in section 2.) on scale "X". Then set the Belt Length under the cursor line, taking care to select the appropriate scale according to the Belt Section chosen.

(*Note that in this instance the Belt Length is the Nominal Inside Length and this can quickly be determined for any given Standard Belt by reference to Table "B".*)

Read off the Combined Power Correction Factor on scale "X" opposite the Service Factor value for the drive. (Latter depends on the duty of the drive and type of prime mover used and is quickly ascertained from the table in section 3.)

EXAMPLE

Using the example already detailed in para. 5., assuming that the electric motor is a high starting torque A.C. motor, the machine is operating for over 10 hours per day and in the medium duty category, find the Combined Power Correction Factor:—

Determine (D-d) = (10-5) = 5.

Nominal Inside Belt Length (from Table "B") = 85 in.

Set Centres to (D-d), i.e., set 31.5 to 5, and read off V-V Factor in window—equals .979.

Set cursor over .979 on scale "X" and set Nominal Inside Belt Length, using B-section scale, under cursor line. (i.e., set 85 under cursor), Service Factor for drive (from table in section 3.) is .72, and reading opposite this value on the Service Factor scale we read the Combined Power Correction Factor—equals .695.

7. Now turn the calculator over and refer to reverse side, sections 4a and b in the centre of the calculator:—

Section 4a. Set the arrow to the Small Pulley Pitch Diameter and read off the Equivalent Diameter opposite the Speed Ratio.

EXAMPLE

Thus, using the example already detailed in previous paragraphs, the arrow is set to 5 and the Equivalent Diameter, opposite Speed Ratio of 2.0, is **5.65 in.**

Section 4b. Using the inner red scale, set the arrow to the R.P.M. of the Motor and read off Belt Speed opposite Small Pulley Pitch Diameter.
(Note that the Pulley Diameter and R.P.M. must always relate to the same shaft, e.g., if the large pulley diameter is used the r.p..m value must be that of the driven shaft.)

EXAMPLE

Using the same details as before, set the arrow to 1440 and read off the Belt Speed opposite 5 in. pulley dia.—**equals 1890 feet/minute.**

8. Finally, to determine the Allowable Horsepower Rating per Belt, use section 5. and proceed as follows:—

Referring to the red curved lines on the main dial, it will be noted that these are in groups with one group for each belt section. Similarly, referring to the two black Belt Speed scales on the clear dial, it will be noted that one is for A, C and E section belts and one for B and D sections. The correct black scale must be used in conjunction with the correct set of red curves.

Now set the Belt Speed on the Black scale over the appropriate equivalent diameter on the red curves and read off the Horsepower Rating per Belt on the outer scale opposite Combined Power Correction Factor.

EXAMPLE

Using the same details as before, set 1890 on the Belt Speed scale over 5.65 on the Equivalent Diameter curves (using the B-section group of curves) and read off the Horsepower Rating—**equals 2.5 H.P. per Belt.**

9. The only remaining part of the calculation is to divide the Total Horsepower required for the drive by the Horsepower Rating per Belt to find the number of belts required:—

EXAMPLE

If, in the foregoing example, the motor Horsepower was 14 H.P. the number of belts required would be:—

$$\frac{14}{2.5} = 5.6 \text{ or 6-belts.}$$

10. Although the above procedure should always be followed before the details of the drive are finalised, the calculator can very successfully be used for rapid approximate sizing. This method of using the calculator is useful for preliminary design work, layouts, estimating, etc., and procedure is as follows:—

USING THE CALCULATOR FOR RAPID APPROXIMATE SIZING

(i) Ascertain the Horsepower of the driving motor, or the Horsepower required to drive the machine and also the Speed Ratio required between driving and driven shafts. Determine the Service Factor for the drive from the table in section 3., but use the next lowest factor from the table. Decide on a provisional diameter for the small pulley (referring to table "A" on back of calculator if guidance is required).

(ii) Use the back of the calculator, sections 4a, 4b and 5 only. Determine Equivalent diameter and Belt Speed in sections 4a and 4b.

(iii) Set Belt Speed over Equivalent Diameter and read off Horsepower Rating per belt against the Service Factor (selected as in para. (i) above) instead of Combined Power Correction Factor.

NOTE—It will be appreciated that, when using the calculator as in (iii) above, it becomes a very simple matter to try the effect of varying pulley diameter, belt section, and number of belts to obtain the most economic size of drive. It is also easy to work back from a pre-determined H.P. per Belt to select a suitable Belt Section and Small Pulley Diameter.

EXAMPLE

Using the same example as before (paras. 7, 8 and 9 above).

Equivalent Diameter	=	5.65 in.
Belt Speed	=	1890 feet/minute.
Motor Horsepower	=	14.
Service Factor	=	.66 (using next lowest value).

The answer, using the rapid sizing method, **would be 2.35 H.P. per belt,** using a B-section belt.

11. V-FLAT DRIVES

Procedure is generally as for V-V drives but it is first necessary to find the Equivalent Pitch Diameter for the flat pulley and this is done by taking its outside diameter and adding on the appropriate increment (see bottom half of Table "A" on back of calculator case). When using section 2. of the calculator the V-Flat factor must be selected.

NOTE—It is not desirable to use the rapid sizing method for V-Flat drives.

EXAMPLE

Design a V-Flat drive for a machine in the Heavy Duty category working 14 hours/day and driven by a $7\frac{1}{2}$ H.P., 960 r.p.m., direct-on-line A.C. motor. The machine is to be driven at 170 r.p.m. using an existing 36 in. diameter flat-faced pulley with B-section belts at 36 in. centre distance.

Speed Ratio $= \frac{960}{170} = 5.65.$

Pitch Diameter of Driven Pulley $= 36 + .54 = 36.54$ in.

Pitch Diameter of Driving Pulley $= \frac{36.54}{5.65} = 6.5$ in.

Section 1.	Calculated length of belt = 146 in., and nearest standard belt pitch length from Table "B" is 145.7 in. with a nominal inside length of 144 in.
Section 2.	(D-d) = (36.54 — 6.5) = 30.04. V-Flat factor = .855.
Section 3.	Service factor = .60. Combined Power Correction Factor = .57.
Section 4a.	Equivalent Diameter = 7.45 in.
Section 4b.	Belt Speed = 1630 feet/minute.
Section 5.	Horsepower Rating per Belt = 2.3 H.P.

Therefore Number of Belts required $= \frac{7.5}{2.3} = 3.26$, i.e., **4-Belts.**

FEARNS CALCULATORS

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