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COMPUTER AIDED ENGINEERING OF MACHINE TOOL DRIVE

Summary. The paper presents a description of a computer program to aid engineering of machine tool feed drives containing d.c. motors together with thyristor feeder, toothed belt transmission and ball screws with bearings. The authors aim was a complex approach to the feed drive engineering problem. Calculation procedures of sets feed drive elements were built by authors, making use the algorithms proposed by producers and were joined to the main program.

1. Introduction

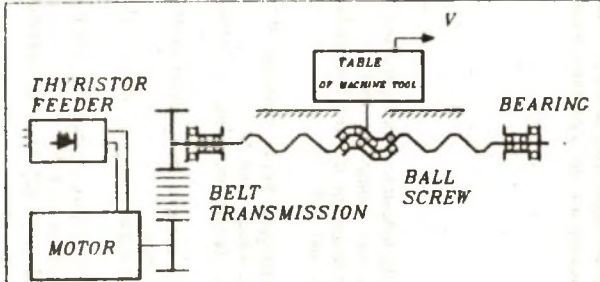
One of the main module of the now-constructed machine tools is the feed drive which comprises both the operation mechanical part and the control system. In the machine tool system the feed drive has a decisive effect on the machining abilities [1]. Most frequently the feed drive includes d.c. motors together with thyristor feeder, toothed belt transmissions and ball screws with bearings (Fig.1).

The number of the constituent elements of the feed drive, multiplied by the multitude of the firms offering elements of the same type, constitutes the first problem which must be solved by an engineer. At the same time, this fact is one of the factors indicating a possibility of computer aided engineering.

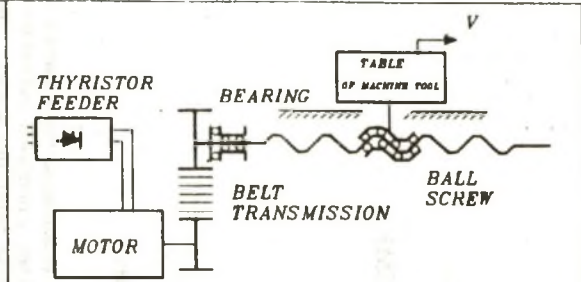
The next factor decisive about computer application is the fact that many of the calculations made have an iteration character. Multiple repetition of the same partial calculations, as well as a possibility of algorithmizing of these calculations, is decisive about the feasibility and advisability of developing computer procedures.

The authors aim was also a complex approach to the problem of feed drive engineering. The procedures of calculating the particular elements of the feed drive have been constructed by the authors acc. to calculation algorithms suggested by the manufacturers [2]. Such an approach made possible the construction of a program in which the choice of the given element constituted at the same time the input data to the successive calculation step without the necessity of independent loading of the data as it is the case of the calculations realized by means of independent programs.

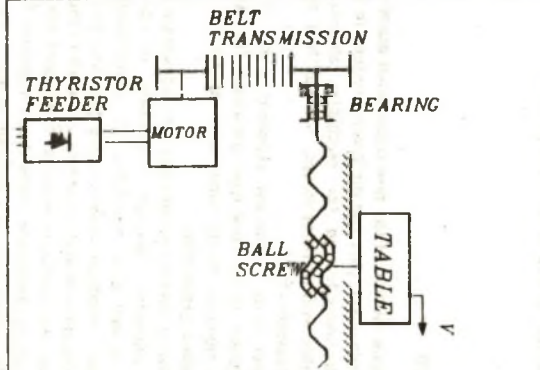
Fig.1. Schematic diagram of the engineered feed drives



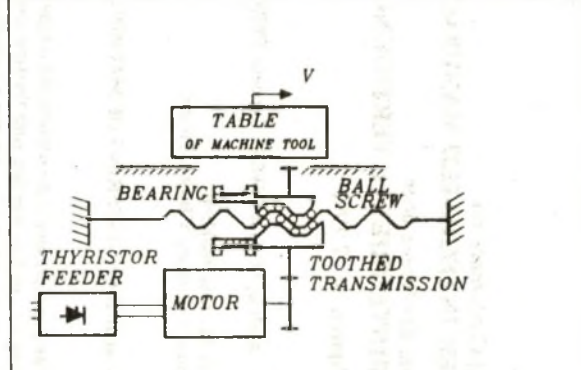
STRUCTURAL FLOW CHART OF FEED DRIVE
(Horizontal Ball Screw, two-sides supported)



STRUCTURAL FLOW CHART OF FEED DRIVE
(Horizontal Ball Screw, One-side supported)



STRUCTURAL FLOW CHART OF FEED DRIVE
(Horizontal Ball Screw, One-side supported)



STRUCTURAL FLOW CHART OF FEED DRIVE
(Horizontal Ball Screw with rotary Nut)

2. Algorithm of calculations

The algorithm of calculations (Fig.2) is composed of successive steps in which the individual constituent elements of the feed drive are calculated or chosen. There are 2 kinds of steps in the algorithm i.e., choice of the element, or verification of the choice of element.

During the selection of the particular element, the type of an element which is the closest to the ideal solution, and which fulfills the assumed constraints is suggested each time.

Also possible is the choice of the elements different from the proposed ones with a simultaneous signalling of fulfilling or lack of fulfilling of the criteria conditions.

The calculation steps in which occurs a verification of pre-choice of elements are of particular importance for the whole course of calculations. By the way of an example, verification of the choice of ball screw is reduced to the verification of the criteria referring to the static load capacity and dynamic capacity of the screw, resonance frequency of the system, insensitivity zone or life of the screw - bearing system. The particular verification criteria are related to various factors e.g., insensitivity zone is related to the coefficients of friction on the shears of machine tool, and also the rigidity of the pre-chosen screw and the rigidity of the selected bearings. The meeting the particular criterion results in the necessity of introducing changes in the pre-established values or elements chosen, and in consequence - the necessity of repeated carrying out of the calculations already done.

The verification step of the choice of motor or feed drive is realized analogically to the verification of the ball screw with a note that in this case the number of the possible combinations is multiplied through the fact of an earlier choice of the elements which may be changed on the level of the particular step.

3. General description of the program

In its structure, the program constitutes a specific environment in which the calculations are realized. Possible in the environment are the operations of recording and reading of the data and results from a disk and the operations of data transfer and calculation results to the printer.

The menu of the main program has been organized on the basis of the system of developed windows. In the main menu is shown the current state of calculations, as well as the basic input quantities for which the calculations are made. In the lower part of the menu "help" is developed in which the assignation of each of the chosen option or sub-options is briefly described. From the level of the main menu there are available 6 main options containing a number of sub-options.

The main options of the program are (Fig.3.):

- "catalog" option: it makes possible a review of the available, from the program level, standard elements manufactured by various firms;
- option of "elements calculation" described below;
- option of "calculations" described below;
- option of "configuration" which makes possible the loading of input quantities. The option also makes possible the setting of the input output paths of the calculation results, as well as a review of the visual drawings of the particular elements of the feed drive;
- option "printouts"; the option offers a possibility of loading the printer or disk with technical data of the individual selected elements, input quantities for the calculations, and the quantities determined in the course of calculations.
- option "description of configurations": an option making possible current review of the quantities determined during calculations, and the technical data of the elements chosen.

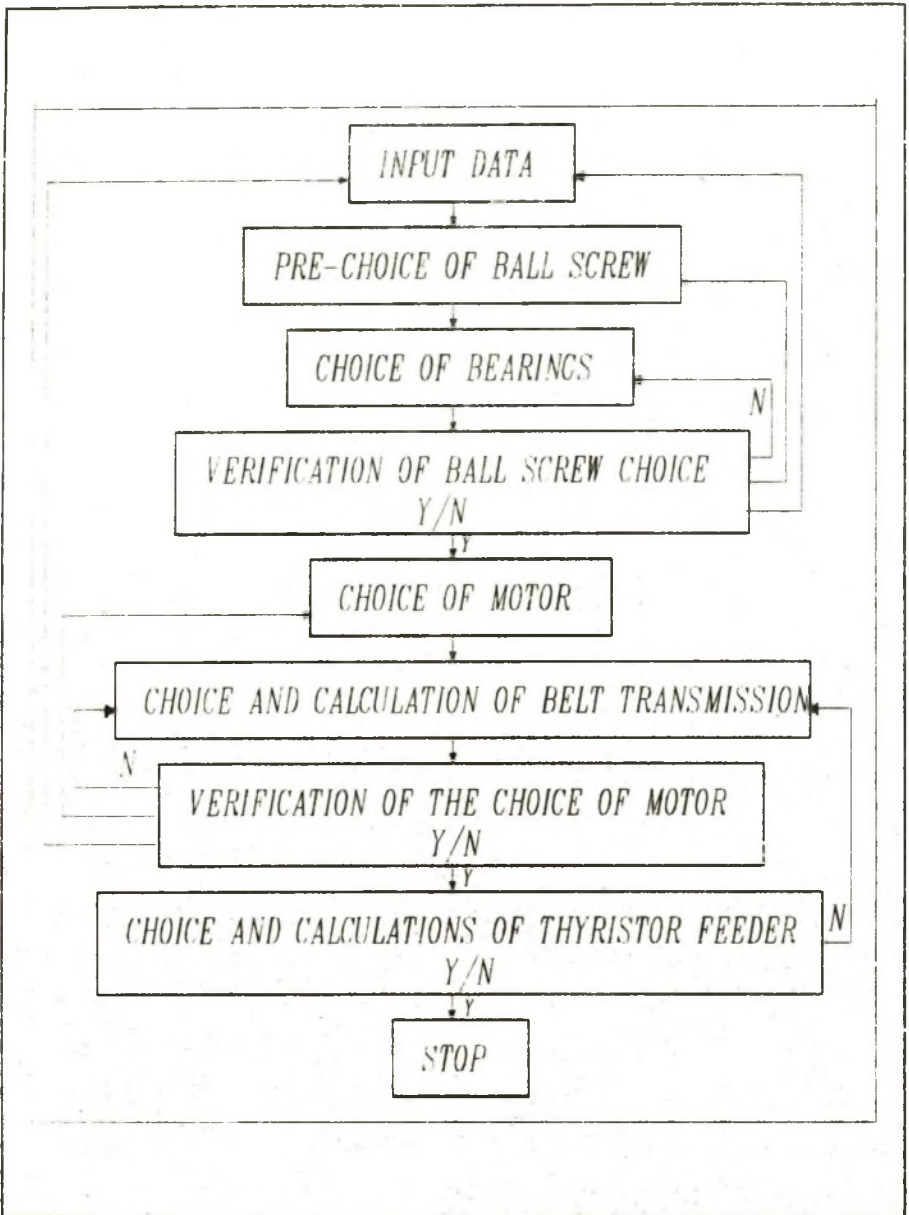


Fig.2. General algorithm of feed drive calculations

Fig.3. Main MENU of the "SERV IBM" program

CATALOGUES	ELEMENTS CALC.	GLOBAL CALC.	CONFIGUR.	PRINTOUT	DESCRIP.
<p>KEY FUNCTION</p> <p>1 - INFORMATION ABOUT PROGRAM ENVIRONMENT</p> <p>2 - DISK CATALOGUES</p> <p>3 - CONFIGURATION OF CALCULATED DRIVE</p> <p>4 - GLOBAL CALCULATION OF THE FEED DRIVE</p> <p>5 - SUPPLEMENT CALCULATION OF FEED DRIVE</p> <p>6 - INPUT OLD CALCULATION FROM THE DISK</p> <p>10 - END OF THE PROGRAM</p>			<p>DESCRIP. OF STATE OF CALCULAT.</p> <p>* Pre-choice of Ball Screw</p> <p>* Bearings</p> <p>* Verificat. of Ball Screw</p> <p>* Pre-choice of Motor</p> <p>* Choice of Belt-transmis.</p> <p>* Verification of Motor</p> <p>* Choice of the feeder</p>		
<p>0 - Choice not made</p>			<p>1 - Choice made O.K.</p>		
			<p>2 - Second Calcul. necessary</p>		
<p>*** MAIN PARAMETERS CONFIGURED THE FEED DRIVE ***</p> <p>Mass of driven El.=400[kg] · Ratio of B. Trans.= 1.0 · Length B.Sc.= 1.5 [m]</p> <p>Max. feed = 600 [mm/min] · Pitch of B.Sc.= 5.0[mm] · Life = 2.0E+4 [hours]</p>					
<p>Comments to choose option (for example: Catalogues)</p> <p>CATALOGUES OF BALL SCREWS, MOTORS, BEARINGS, THYRISTOR FEEDERS</p>					

The calculations may be realized from level 3 of various sub-options. The first of them (the option of the calculation of elements) assumes an interference of the engineer in the course of the calculations through manual selection of the particular calculation steps.

In the second case (calculation option) the calculations of the whole drive are realized automatically with intervals for decision making about the elements of the feed drive proposed by the program, or the quantities resulting from intermediate calculations.

In the case then the calculations are not complete, the input data were changed or one of the constituent elements of the drive designed was changed, one may make use of the sub-option realizing the completion of the calculations (calculation option). In this case the program, in an intelligent way, selects these calculation steps which are required from the point of view of the changes made earlier.

4. Summary

The program presented here in a general way aims at aiding engineering activities in designing offices of the plants manufacturing machine tools. The present program has been used in the didactic process at the Institute of Machine Construction of the Silesian Technical University in Gliwice, and has been implemented in the factories RAFAMET in Kuznia Raciborska, FAT in Wrocław and DEFUM in Dąbrowa Górnicza.

REFERENCES

- [1] Mierzejewski J.: Servomotors of numerically controlled machine tools. Wydawnictwa Naukowo Techniczne, Warsaw 1977
- [2] Catalogs of AVIA-Poland, PORTER-United States, INA-Germany, UNIROYAL-United States, STAR-Germany, SIMENS-Germany

COMPUTERUNTERSTÜTZUNG DER VORSCHUBANTRIEBPROJEKTIERUNG

Zusammenfassung

In dem Bericht ist eine Beschreibung ein Computerprogramm zu der Unterstützung der Vorschubantriebprojektierung vorgestellt. Der Antrieb ist von Gleichstrommotor mit Thyristorfeeder, Riemen-Zahnradgetriebe, Kugelgewindetriebe mit Kugellager zusammengesetzt. Die Autoren wollten die Vorschubantriebprojektierung komplexe erfassen. Die Autoren haben die Abrechnungprozedure den Vorschubantriebelementen gebaut. Sie haben die Abrechnungsalgorithme vorgeschlagen vom Hersteller ausgenutzt und zu dem Hauptprogramm angeschlossen.

KOMPUTEROWE WSPOMAGANIE PROJEKTOWANIA NAPĘDÓW POSUWOWYCH OBRABIAREK

Streszczenie

W artykule przedstawiono program komputerowy dla wspomaganie projektowania napędów posuwowych obrabiarek. Napęd posuwowy składa się z: silnika prądu stałego, zasilacza tyrystorowego, przekładni paskowo zębataj i przekładni śrubowo-toczonej. Celem pracy było kompleksowe ujęcie problemu projektowania napędów posuwowych. Opracowany został algorytm obliczeniowy dla wszystkich elementów napędu. Poszczególne procedury obliczeniowe opracowano na podstawie zaleceń producentów elementów napędu.

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